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Differential psychophysiologic reactivity and the Type A behavior pattern

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and the
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Abstract

Since 1975, many studies have attempted to show that Type As are sympathetically hyperreactive to environmental stimuli compared to Type Bs. Inconsistencies in findings have led Holmes (1983) to challenge the basic assumption that a link exists between the Type A behavior pattern and processes which precipitate development of coronary heart disease. The present study was an attempt to isolate the organismic variable psychophysiologic reactivity and demonstrate through a replication-extension of Holmes, McGilley, and Houston (1984) that individual psychophysiologic reactivity rather than the personality profile of Type A is predictive of heightened arousal due to challenge. Reactive and nonreactive Type As and Type Bs were selected from a pool of 136 male undergraduates. All were exposed to increasingly difficult levels of the WAIS digits recall backwards and block design tasks, during which heart rate, blood pressure, and electrodermal response were measured. Results show reactives evinced significantly higher systolic blood pressure across challenges compared to nonreactives. Types As and Bs did not differ in their physiologic responses to challenges.

Differential Psychophysiologic Reactivity and the Type A Behavior Pattern

Coronary heart disease was America's leading killer in 1980, claiming 650,000 lives, of whom 175,000 were under the age of 65. An additional 100,000 Americans suffered strokes, 30,000 of which were fatal (Fishman, 1982). According to the National Heart, Lung, and Blood Institute, a large percentage of premature deaths, those occurring between the ages of 35 and 50, were the result of clinically manifest coronary heart disease (Fishman, 1982).

Coronary Heart Disease

Coronary heart disease (CHD) is a clinical disorder produced by complications resulting from coronary artery disease. Atherosclerosis is a form of coronary artery disease in which the innermost layer of the coronary artery thickens due to fatty deposits. These deposits, called atheromata, decrease the diameter of the central channel (the lumen) of the coronary artery and impede the flow of blood (Glass, 1977).

The initiating event in the process of atherosclerosis involves trauma to the inner wall of the coronary artery possibly caused by movements of the artery as it carries blood to the heart. A self-healing process ensues in which newly formed cells cover lesions thereby producing arterial thickenings. The cells that make up the thickening are mostly lipids and are compositely termed the "fatty streak" (Glass, 1977).

Atheromatous plaques begin to form as lipids and cholesterol accumulates at the site of fatty streaks. Plaque formations expand and multiply, narrowing the lumen of the artery and restricting the blood supply to the heart. Diminished oxygen supply to the heart results in necrosis (death) of heart tissue which leads to myocardial infarction and often death. Alternately, plaque deposits can rupture and become lodged within the already narrowed arterial lumen causing a clot or thrombus to occlude the coronary artery, again leading to myocardial infarction. It is at the point when myocardial necrosis begins, that atherosclerosis has developed into coronary heart disease (Glass, 1977).

Risk Factors

Epidemiologic studies have isolated a number of factors which appear to place individuals at greater risk for development of coronary heart disease. Among these are smoking, physical inactivity, elevated serum cholesterol, gender (being male), hypertension, diabetes mellitus, family history, and obesity. Still, these factors combined predict less than one half of new cases of CHD (Jenkins, 1976). Hence, the scope of biomedical research has broadened to encompass a set of psychological and social behaviors implicated as a unique risk factor in coronary heart disease.

Type A Behavior Pattern

The Type A behavior pattern is characterized by aggressiveness, impatience, hostility, hard-driving competitiveness, achievement-striving, time-urgency, and a low sense of security. Behaviorally, these characteristics are seen in displays of impatience at the speed of events, setting deadlines which are often unrealistic, expressing explosive voice and psychomotor mannerisms which communicate aggressiveness, and engaging in many tasks simultaneously. In the landmark Western Collaborative Group Study of 3,145 men, Rosenman (1975) demonstrated that, over an 8-1/2 year period, the annual rate of CHD was 13.2 per 1000 Type As compared to 5.9 for Type B persons (those showing an absence of Type A behaviors). Risk for CHD was over two times greater for Type As independent of other risk factors. Type A has been associated with (a) the incidence and prevalence of clinically manifest coronary heart disease in both men and women, (b) recurring myocardial infarction, and (c) arteriographically documented severity of atherosclerosis (Dembroski, MacDougall, Herd, & Shields, 1979).

Assessment of Type A

The complex nature of the Type A behavior pattern has been assessed using a multitude of measures including the Bortner Scale, the Thurstone Temperament Schedule, the Gough Adjective Checklist, the Sales Type A measure, the Framingham Type A Scale, the Jenkins Activity Survey, and the Structured Interview (Matthews, 1982). However, only the latter three have been prospectively linked to coronary heart disease and of those, only the Structured Interview and the Jenkins Activity Survey have emerged as generally accepted Type A classification instruments. While they have been used interchangeably, there is evidence from psychophysiological studies that these measures assess different aspects of Type A behavior pattern and are only modestly correlated with each other.

Structured Interview. The Structured Interview contains 25 questions about the individual's characteristic way of responding to various situations. Classification is based largely on the psychomotor and voice characteristics of the interviewees' responses to challenging questions in addition to the content of their responses. Some questions are posed with deliberate hesitancy to detect impatience in Type As, who typically interrupt the interviewer. Others confront the interviewee, challenging the accuracy of his or her responses. Based on the judgment of a trained interviewer, individuals are classified into one of four categories: A1, or fully developed Type A; A2, or incompletely developed Type A; X, or an equal representation of Type A and Type B characteristics; and Type B, or the absence of Type A characteristics (this is occasionally further broken down into Types B_3 and B_4).

Although the rate of CHD has decreased slightly over the past few years, the proportion of individuals classified as Type A1 or A2 has increased in recent studies, raising concern among some (Matthews and Glass, 1981) that the ability of the interview for predicting coronary disease has weakened. Clearly, if this trend continues, larger numbers of persons who will not develop coronary heart disease might be categorized as being at high risk for disease. Increased public awareness of the risks of smoking and high serum cholesterol in addition to the growing popularity of physical fitness programs may be partially responsible for the decline in CHD incidence.

Jenkins Activity Survey. The Jenkins Activity Survey (Appendix A) is a self-report measure of Type A, containing 52 questions of which only 21 contribute to the Type A score. The remaining items are included to reduce hypothesis guessing by subjects. Among the 21 items which comprise the Type A score are: five on hard-driving competitiveness, eight on immediate quick action, seven on pressured style of working (taking work seriously, perceiving deadlines at work), and one on hostility.

Cut-off scores for the Jenkins have ranged from differentiating As from Bs based solely on the population's median split (Glass, 1977) to accepting only the top and bottom 10% of the population distribution (Suinn, 1982). Ambiguous standards for scoring the Jenkins Activity Survey may contribute to inconsistencies in the results of studies using the JAS for "type" classification. Currently, there appears to be consensus in the literature that the top and bottom

20% of Jenkins Activity Survey scores in a large population is satisfactory for differentiation (Holmes, 1983; Houston, 1983; Matthews, 1982).

Because the Jenkins Activity Survey appears to be a reliable and valid measure of Type A and can be administered to large numbers of subjects, it is currently the most widely used Type A measure. Unfortunately, it was a poorer predictor than the Structured Interview of incidence of coronary heart disease in the Western Collaborative Group Study (Brand, Rosenman, Jenkins, Sholtz & Zyzanski, 1978). As Matthews (1982) points out, "the measures assess different behavioral characteristics, share little common method variance, and have been used in different kinds of studies. Nonetheless, both are related to incidence of coronary heart disease and assess some of the behaviors collectively called the Type A behavior pattern" (p. 304). Glass (1977) found that the Structured Interview and Jenkins Activity Survey did classify people similarly above chance levels (*r*=.73 using JAS median split criterion; *r*=.88 to.91 using top and bottom quintiles).

Comparison of Type A Measures. Factor Analyses of Jenkins Activity Survey responses have yielded three factors which have been termed: hard-driving/competitive (H), speed/impatience (S), and job-involvement (J) (Jenkins, Rosenman & Zyzanski, 1974). A student version of the Jenkins Activity Survey, designed for college students, is virtually identical to the adult version except that job-involvement items were modified to relate to college coursework. Only hard-driving/competitive (H) and speed/impatience (S) factors contributed substantially to the total variance in factor analyses of this version.

Factor Analyses of the Structured Interview responses of 186 men enrolled in the Western Collaborative Group Study revealed five primary factors of which only two -- hard-driving/competitiveness and impatience/hostility were associated with later onset of coronary heart disease. These factors were most similar to the factors of both versions of the Jenkins Activity Survey.

The unique contribution of the Structured Interview which increases its predictive validity for coronary heart disease relative to the Jenkins Activity Survey may be its ability to more accurately measure individual psychophysiologic reactivity which is manifested in speech and psychomotor behaviors during the interview. Indeed, Friedman et al. (1982) reports a significant relationship between Type A speech behaviors and elevations in blood pressure and heart rate. If such an indirect measure of cardiovascular reactivity such as psychomotor and speech behaviors does increase the predictive validity of the Structured Interview for CHD, perhaps a more complete measure of cardiovascular reactivity could be used in conjunction with the Structured Interview or the Jenkins Activity Survey to further strengthen the predictive validity of Type A Classification for coronary heart disease. The need for a more discriminating measure is evident in that only about one percent of individuals classified as Type A will actually develop CHD. Indeed about 99% of Type A "coronary prone" individuals are not coronary prone at all (Roseman, 1975).

There is a growing body of evidence that it is the interaction of the organismic variable -- psychophysiologic reactivity and Type A behavior pattern that may be critical to the development of coronary heart disease. However, psychophysiologic reactivity has not been isolated as an independent variable in Type A research, nor have psychophysiologic reactive Type As been prospectively studied for development of CHD. These omissions are curious in light of the fact that the currently accepted theories that link Type A behavior pattern and coronary heart disease involve hyperreactivity of the sympathetic-adrenomedullary branch of the autonomic nervous system during perceived challenges. The specific types of challenges and situations which evoke hyperreactivity in Type As versus Type Bs and the various physiologic responses indicative of hyperreactivity to those stimuli have been the focus of numerous investigations.

If it can be demonstrated that subgroups of Type As exist that are either particularly reactive or nonreactive to environmental stressors, a more refined evaluation of risk for coronary heart disease might be possible. It seems plausible that two individuals, both classified as competitive, achievement-oriented, outwardly aggressive, and time conscious might have vastly different psychophysiologic constitutions. While one moves briskly through his day maintaining a stable heart rate and blood pressure, the other experiences frequent states of panic accompanied by dramatic hemodynamic effects that gradually deteriorate and impair cardiac functioning. Both individuals would be classified Type A, but only one might actually be "at-risk" for coronary heart disease.

Similarly, two individuals might be quiet, somewhat reserved, noncompetitive, moderately motivated and nonaggressive. Both of these individuals would likely be categorized Type B. However, while one reacts to a relevant challenge with accelerating heart rate and escalating blood pressure, pupil dilation and peripheral vasoconstriction, the other remains cool and collected with few physiological signs of upset. Unlike the reactive Type A, the reactive Type B might be expected to avoid encounters of a stressful nature, even if personal achievement is sacrificed.

Before proceeding with a survey of various studies which support this hypothesis, a discussion of the relationship between pathophysiologic mechanisms, Type A behavior, and CHD is in order.

Pathophysiologic Mechanisms

Recent research on the differential cardiovascular physiology of noncardiac and cardiac patients has led to a number of findings relevant to the hypothesis that Type As are physiologically more reactive to environmental stressors than their Type B counterparts.

Kalsner and Richards (1984) examined coronary arteries obtained postmortem from patients with and without a history of coronary artery disease and pathological evidence of myocardial damage. Coronary arteries from the hearts of cardiac patients contained significantly higher concentrations of amines, especially histamine, than did those from noncardiac patients. Spontaneous phasic activity and varying degrees of spontaneous tone were observed in a number of preparations from cardiac and noncardiac patients. Vessels from cardiac patients responded with markedly greater contractions than did those from noncardiac patients. The authors also cite evidence that vascular tissue is more reactive in patients with diverse chest pain syndromes (e.g., angina pectoralis) and that spasms induced with a cold-pressor task begin at the site of an atheromatous plaque (Kalsner & Richards, 1984). It is possible that biochemical and structural differences between these patients increased vulnerability to fluctuations associated with hyperreactivity.

The blood of coronary and noncoronary patients has also been analyzed to detect cardiovascular pathogens (Mustard & Packham, 1969). A predominance of catecholamines (e.g., epinephrine and norepinephrine) in the blood of coronary patients has led to the hypothesis that these substances increase the adhesiveness and subsequent deposition of blood platelets on the surface of a coronary artery plaque. The aggregation of platelets increases plaque size hastening the rate of development of coronary heart disease.

The model for sympathetic nervous system activation suggested by Hassett (1978) offers a mechanism by which catecholamines are infused into the bloodstream, and overall cardiovascular functioning is impaired. Afferent nerves transmit impulses which communicate to the autonomic nervous system the presence of a threatening stimulus. The autonomic nervous system, with its sympathetic and parasympathetic branches, regulates the state of the heart, the glands, and the smooth muscles. Upon reception of afferent signals, the sympathetic nervous system mobilizes the body to meet the demands of the stressor by accelerating heart rate, constricting peripheral arteries via smooth muscles, and stimulating release of catecholamines from the adrenal medulla. Catecholamines accelerate lipid metabolism and stimulate the release of free fatty acids.

The interrelationships of these various events is significant. Cardiac output increases as stroke volume remains constant and heart rate increases. Blood pressure rises as cardiac output and peripheral resistance increases. Cholesterol and triglycerides may act in concert with cathechols to increase resistance in peripheral vascular beds and arterial walls. Eventually structural changes in the arterioles and peripheral vasculature become irreversible and atherosclerosis develops. Further increases in heart rate lead to essential hypertension as cardiac output increases.

Recurrent and prolonged sympathetic activation may lead to hypertension and atherosclerosis and, over time, to coronary heart disease. It is through this neural and biochemical pathway that the sympathetic nervous system has been implicated as mediator between Type A and CHD.

Whether these events do occur to a greater extent in Type As than in Type Bs has not been demonstrated. All that is really known in this domain is that risk for coronary heart disease is over twice as great for Type A individuals, independent of all other known risk factors (Rosenman, 1975). A vast literature attempting to establish the association between Type A and heightened sympathetic activation has evolved. Much of this research is relevant to the present study.

Type A Behavior And The
Sympathetic Nervous System (SNS)

Research on the relationship between Type A and the sympathetic nervous system has typically involved mixed subject pools (Type As and Type Bs) who are presented with tasks of varying levels of difficulty and salience (personal relevancy). Physiological outcomes such as heart rate, blood pressure, pulse transit time, serum lipids, and peripheral vasoconstriction, are measured before, after, and ideally, during task performance. In this paradigm, Type As are expected to express greater sympathetic activation relative to Type Bs, especially under high challenge conditions. A few representative studies will be mentioned followed by an overview of the strengths and weaknesses of this approach.

Dembroski, MacDougall, Herd, and Shields (1979) subjected 84 male college students to cold pressor and reaction time tasks under high and low challenge conditions. Type A/B classification was based on scores from the Structured Interview, Jenkins Activity

Survey, and Framingham Scale.

The cold pressor task required subjects to submerge their right hand into an insulated bucket of 4^{o}C water until the experimenter indicated that 75 secs had elapsed. Under the low challenge condition, subjects were calmly told that they would be performing a common physiological maneuver that was easily accomplished by all persons. In contrast, high challenge subjects were briskly led into the experimental room and advised of the extreme difficulty of the task and that enormous will power would be required to keep their hand immersed for the entire period.

The second task, which followed the cold pressor test and a 3 min baseline was a reaction-time test. Low challenge subjects were simply instructed to depress a telegraph key when a green light was illuminated. No emphasis was placed on speed or accuracy. High challenge subjects were advised that they were being tested on speed and accuracy and therefore should avoid making mistakes. Heart rate and blood pressure were monitored throughout the experimental procedure on all subjects.

Type As showed higher levels of systolic blood pressure and heart rate in response to both tasks when compared to Bs and highest HR/BP changes under high challenge conditions. No significant differences between "types" existed for diastolic blood pressure. When Type A subjects were retrospectively divided into high and low Hostility/Competition groups (based on Jenkins Activity Survey factor loadings), individuals high on this dimension had blood pressure elevations even in the low challenge condition. The authors found that hostile/competitive Type As were more physiologically reactive and suggested that they may be at high risk for coronary heart disease regardless of environmental demands. Schematically, their hypothesis is presented in Figure 1.

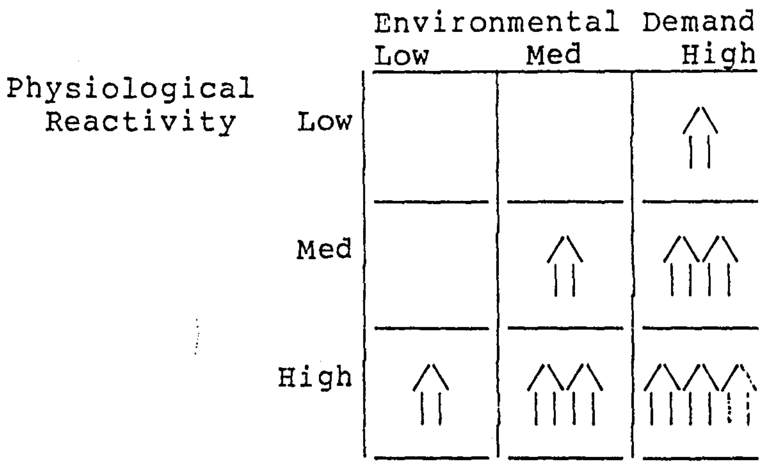


Figure 1. "Schematic representation of the hypothesized relationship between physiological reactivity and environmental demand in the production of CHD risk. Arrows represent the demand of hypothesized risk inherent in each combination of persons and environmental variables" (Dembroski, et al., 1979, p. 224).

Theoretically, this is a most appealing hypothesis and has direct implications for the proposed study. Dembroski et al. (1979) suggest that a person variable, namely physiologic reactivity might place an individual at risk for CHD independent of all other risk factors. Unfortunately, this hypothesis has never been tested experimentally and the interaction between Type A characteristics and Physiologic Reactivity has not been measured to determine their combined effects on CHD development. Instead, the major research emphases have been placed on environmental variables such as level of challenge and conditions which elicited SNS elevations in Type As but not Type Bs.

Goldband (1980) raises the question of whether particular stressors are associated with greater hyperreactivity than others. If so, what are the characteristics of these stressors that differentiate Type As from Type Bs? Reaction time and cold pressor tasks were presented to 231 male college students classified as Type A or B by median split scores on the Jenkins Activity Survey. In a 2x2x2x2 factorial design, stress relevance was manipulated under the following conditions: Competition (neutral instructions versus comparisons against the performance of an "average subject"), Time-Urgency (deadline, varied to result in 90% success for group one versus 50% success for group two), and Feedback (reaction-time performance feedback versus no feedback).

Physiologic dependent variables included catecholamine excretion, measured by pulse transit time (the time between the R-wave of the EKG and pulse of the radial artery, p. 673) and heart rate.

Results indicated no significant differences between Types for either task in heart rate or pulse transit time. However, there was a significant difference between Type As in the high and low-challenge conditions indicating sympathetic activation with increased challenge.

Lane and Kuhn (1982) compared cardiovascular and neuroendocrine responses of 21 male undergraduates classified as Type A or B by Structured Interview and Jenkins Activity Survey scores. Two tasks, arithmetic (mental) and reaction time (sensory), were alternately presented during which heart rate, blood pressure, blood flow, peripheral resistance, and blood chemistry (catecholamines, cortisol, prolactin, and testosterone) were continuously monitored.

Results indicated that during "mental work," Type As showed slightly greater muscle vasodilation (as measured by blood flow), and enhanced secretion of catecholamines and cortisol than Type Bs, but the only statistically significant difference between Types was for increased testosterone in As. This unusual finding served to increase the number of questions about the relationship between Type A and sympathetic nervous system activation, especially since the relevance of the arithmetic task was expected to elicit more competitive and, theoretically, more reactive behavior by Type As.

Since 1982, many studies have produced evidence that Type As are sympathetically hyperreactive to environmental stimuli (Contrada et al., 1982; Holmes, McGilley, & Houston, 1984; Ortega & Pipal, 1984). At the same time, however, a number of similar studies have reported negative findings (Contrada et al., 1982; Lovallo & Pishkin, 1980; MacDougall, Dembroski, & Krantz, 1981; Pittner & Houston, 1980).

Of the few conditions that seemed to elicit greater cardiovascular arousal among Type A subjects compared to Type Bs were (1) a moderate external incentive to perform well on the task, and (2) an intermediate probability of failure on the task. In tasks with high incentive, Type Bs responded like Type As and became physiologically aroused, and on highly difficult tasks Type As gave up (often before their Type B counterparts).

Overall, the equivocal results of these studies led Holmes (1983) to challenge the basic assumption that a link exists between Type A behavior pattern and heightened sympathetic reactivity. Citing heart rate and blood pressure results from 18 studies, Holmes argues convincingly that no real pattern of sympathetic hyperreactivity in Type As has been demonstrated.

Several explanations for the ambiguity in results can be offered. First, no standard Type A measure or combination of measures was used across studies, raising the possibility that many subjects were classified incorrectly. Secondly, not only did task difficulty vary across experiments, but degree of challenge was often not manipulated. Third, many of the studies cited used females or both sexes as subjects. The data to date suggest that males may be more prone than females to respond to a wide array of environmental challenges with enhanced blood pressure and heart rate responses. This may contribute to the well-known sex difference in incidence of CHD (Waldon, 1978). Type A is predictive of CHD in women, but the environmental circumstances that elicit those processes that may increase risk for CHD in Type A women appear to differ from those of Type A men.

Perhaps most importantly, however, there may be a secondary source of variance in those methodologically similar studies that is operating independent of Type A to exert an effect on physiologic dependent variables. I suggest that the hidden factor is the person variable -- psychophysiologic reactivity, which was precociously proposed by Dembroski et al. (1979) to have an effect on CHD independent of other factors. Although psychophysiologic reactivity per se cannot yet be regarded as a proven risk factor for CHD (Krantz & Manuck, 1984), the interaction effect of Type A and psychophysiologic reactivity may be a far more refined predictor of CHD than either variable alone. Lovallo and Pishkin (1980) point out that "the research thus far supports the contention that As may differ from Bs in autonomic reactions to moderate stress, but it can be of value to identify a particularly reactive subgroup of As." MacDougall, Dembroski, and Krantz (1981) recommend that "maneuvers that may make it possible to go beyond the A-B dichotomy by using physiologic reactivity as a direct predictor of CHD" should be developed. "More specifically, it is plausible that such maneuvers may be able to identify dispositional hyper and hypophysiologic responders and permit use of this individual difference variable . . . to enhance prediction of CHD." "Perhaps exploration of Type A behaviors together with dispositional physiologic reactivity may ultimately change the fact that most new cases of CHD cannot presently be explained by the best combination of existing risk factor variables" (p. 8).

Hypothetically, if each variable contributes slightly to cardiovascular fluctuations, reactive Type

As would 1) be expected to show greatest arousal to relevant challenge. 2) Reactive Type Bs should respond physiologically most like Type As, since physiological arousal will naturally accompany their perception of challenge. 3) Nonreactive Type As would be expected to exhibit only slight physiological arousal due to the increased level of activity associated with competitiveness and achievement orientation. Finally, nonreactive Type Bs would be expected to be least physiologically responsive. This hypothetical relationship is presented in Figure 2.

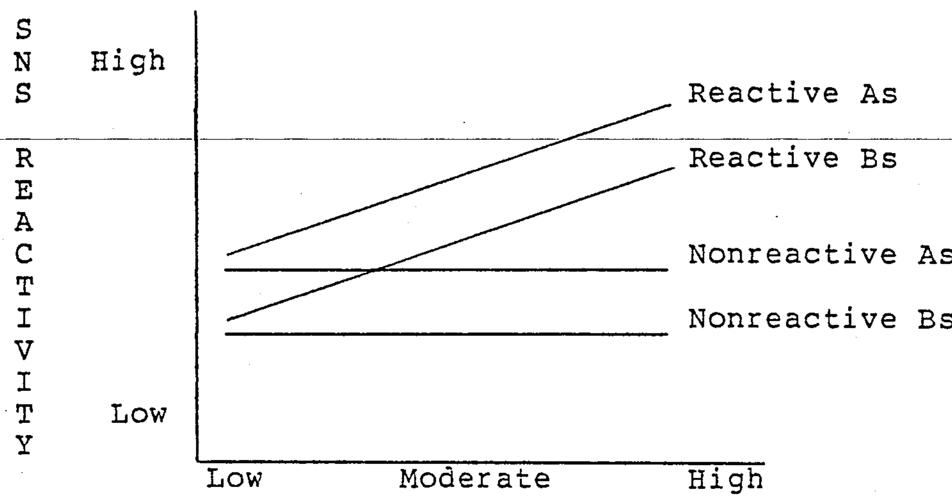


Figure 2. The hypothetical relationship between sympathetic nervous system reactivity and varying degrees of perceived challenge in reactive versus nonreactive Type A and B males.

Proposed Study

A vast literature attempting to establish the link between Type A behavior pattern and the pathophysiologic processes which are thought to lead to coronary heart disease has evolved since Rosenman's Western Collaborative Group Study of 1975. Environmental variables that typically evoke heightened sympathetic responsivity in Type As versus Type Bs (e.g., moderate task difficulty, moderate incentive, and high salience) have been isolated. Still, under conditions in which these variables are relatively well controlled, Type As compared to Type Bs do not show a consistent pattern of heightened sympathetic nervous system arousal. When differences do occur they tend only to be for increased systolic blood pressure and pulse rate for Type As compared to Type Bs (Holmes, 1983). Prolonged or recurrent hemodynamic effects of this type to perceived challenges are considered to precipitate formation and deposition of atheromatous plaques in the arteries which ultimately impairs cardiovascular functioning. It would therefore be desirable to demonstrate conclusively that at least some subgroup of Type As consistently reacts to such challenges with heightened SNS arousal.

Evidence has been presented which implicates the organismic variable -- psychophysiologic reactivity as a possible source of secondary variance that has contributed to the ambiguity in results of Type A/ sympathetic arousal research. The purpose of the present study is to test the hypothesis that psychophysiologically reactive and nonreactive Type As and Bs exist in the population. If nonreactive Type As and/or reactive Type Bs do exist in the population then the failure to demonstrate a Type A/B main effect (primary variance) in much of the recent research may be due to the secondary variance effect of individual psychophysiologic reactivity.

As independent variables, neither Type A nor psychophysiologic reactivity have been reliably linked to processes underlying the development of coronary heart disease. Perhaps the interaction of Type A and individual psychophysiologic reactivity is necessary to produce heightened sympathetic nervous system responses of the kind that impair cardiovascular functioning over time. On the other hand, perhaps psychophysiologic nonreactivity protects some Type As from radical hemodynamic shifts. These nonreactive Type As might be expected to be included among the 977 per 1000 Type As that never develop clinically manifest coronary heart disease.

In a study methodologically similar to many of the recent research attempts to link Type A with sympathetic nervous system arousal, Holmes, McGilley, and Houston (1984) subjected 60 Type A and B male undergraduates (identified by the top and bottom quintiles of the student version of the Jenkins Activity Scale; Krantz, Glass & Snyder, 1974) to the Digits Backward Recall test of the Wechsler Adult Intelligence Scale (Wechsler, 1955). Systolic blood pressure, diastolic blood pressure, pulse rate, skin resistance, and subjective arousal were measured during a 5 min rest phase and a 5 min test phase. Subjects were randomly assigned to one of three test conditions: easy, a series of three digits backwards; moderately difficult, five digits backwards; and extremely difficult, seven digits backwards. Six problems of the appropriate level of difficulty were presented to the subject during which his responses were recorded. Finally, the subject was asked to complete a brief questionnaire using a five-point scale to indicate how difficult he perceived the task to be, how he felt while working on the task, and the degree to which he would prefer a future task to be easier or more difficult.

Separate analyses of variance were performed on each of the physiologic dependent variables. The only significant results indicated that Type A subjects evidenced reliably higher systolic blood pressure than did Type B subjects at the highest level of challenge ($p < .01$). Even so, the magnitude of difference, 7.52 mm Hg, might not be considered clinically useful. There were no reliable differences between the subjects in systolic blood pressure at the other levels of challenge or on any of the other measures of arousal.

The present study was a partial replication of Holmes, McGilley, and Houston (1984). However, in addition to selecting subjects on the basis of Jenkins Activity Survey Type A and Type B scores, subjects will be screened for psychophysiologic reactivity versus nonreactivity using two measures: the Autonomic Nervous System Response Inventory (ANSRI) developed by Waters, Cohen, Bernard, Buco, and Dreger (1984) to measure "individuals' self-reported patterns of peripheral physiological response to emotion-provoking stimuli" (p. 315), and the Pacific Psychophysiologic Reactivity Scale developed by this author and the graduate Research Design class (1984) of the University of the Pacific.

The ANSRI (Appendix B) contains 51 Likert-scaled items reflecting presence or absence of sympathetic nervous system responses (1=absent to 5=intense) during prototypical emotional situations drawn from personal experiences. P scales were developed based on physiological coherence of items (e.g., cardiac, muscle tension, thermoregulation). Test-retest reliability for all items was .85 and coefficient alpha was .97 for males.

The Pacific Psychophysiologic Reactivity Scale (Appendix C) contains 31 Likert-scaled items reflecting presence or absence of typical sympathetic nervous system responses to hypothetical situations. Like the ANSRI, internal consistency for the PPRS is relatively high (coefficient alpha=.92).

Method

Design

A 2(Types: A vs. B) X 2(Reactivity vs. Nonreactivity) X 2(Task: Digits Backwards vs. Block Design) X 3(Level of Challenge: Easy vs. Moderate vs. Extremely Difficult) factorial design with repeated measures was used to test the hypothesis. Reactive and nonreactive Type As and Bs experienced all three levels of both tasks (i.e., Type and Reactivity were the between-groups variables; Task and Challenge were the within-groups variables).

Subjects

One hundred and thirty-six male undergraduates from psychology courses, dormitories, and fraternities at the University of the Pacific took the student version of the Jenkins Activity Survey (JAS: Krantz, Glass, & Snyder, 1974), the Autonomic Nervous System Response Inventory (ANSRI: Waters, Cohen, Bernard, Buco, & Dreger, 1984), and the Pacific Psychophysiologic Reactivity Scale. The battery of questionnaires took approximately 35 min to complete and were administered individually. To be selected for participation in the experiment, students had to score within the highest or lowest quintiles of the JAS distribution and have ANSRI scores at least one-half standard deviation above or below the ANSRI mean. Those with high ANSRI scores were classified as "reactives" and those with low ANSRI scores were termed "nonreactives." The group means on the JAS and ANSRI were as follows: Type A(N = 24), *M* =13.08, *SD* = 1.68; Type B(N = 33), *M* = 3.88, *SD* = 1.18; Reactive (N = 27), _M_ = 294.07, _SD_ = 35.14; Nonreactive (N = 30), _M_ = 164.28, _SD_ = 23.30. A total of 30 subjects who met both reactive/nonreactive and Type A/Type B criteria were selected for participation in the study (6 Type A reactives, 6 Type A nonreactives, 9 Type B reactives, and 9 Type B nonreactives).

The proposed multiple cut-off criteria using the PPRS in addition to the other two measures proved to be too restrictive given the relatively small sample size. The ANSRI cut-offs also had to be lowered from the proposed one standard deviation above and below the mean to 1/2 SD to provide for adequate cell sizes. The ANSRI was selected as the single reactivity measure ~~because it is currently more fully validated than the~~ PPRS (Waters, Cohen, Bernard, Buco, & Dreger, 1984).

Subjects were telephoned and scheduled for 75 min appointments. They were told that they would participate in a series of exercises during which they would be observed. They were paid 5 dollars for their participation.

Apparatus

A Copal Model UA-251 Digital Sphygmomanometer Model with dot matrix thermal-type printer was used to record systolic and diastolic blood pressure in mm Hg and pulse rate in beats/min. Measurement range is 20 to 280 mm Hg (Pressure) and 40-200 pulse/minute (Pulse). The sphygmomanometer was attached to the subject's nondominant arm with a Piezo-electric ceramic microphone placed above the brachial artery for detection of Korotkoff sounds. A Coulbourn Instruments Autoclinic 2001 with cutoff filter frequencies set at 1(Low Cut) to 4(High Cut) Hz was used to detect electrodermal activity. Silver/silver chloride electrodes were attached to the distal and palmar surfaces of the nondominant hand with a wrist electrode ground. EDR recorded in microvolts/sec. was recorded for 1 min during the last half of all tasks.

Procedure

When the subject arrived for his appointment, he was given an explanation of the general experimental procedures that were followed in the experiment and an informed consent statement to be signed (Appendix D). After signing the consent form, subjects were taken into a cubicle and seated at a desk. Physiological sensors and recording equipment were then attached.

Task A (Rest Phase). A tape-recorded set of instructions first asked the subject to sit quietly and relax for 5 min. This period was used to allow him to adapt to the situation and allow the experimenter to record the subject's resting level of physiological arousal twice during the last minute of the rest period. As with all subsequent trials, systolic and diastolic blood pressure, pulse rate, and electrodermal activity were recorded. At the end of this phase, and all subsequent phases, the subject was asked to use a 9-point scale to indicate the degree to which he was subjectively aroused. All subjects experienced the digits recall tasks first followed by the block design tasks and a posttask rest phase.

Task A (Easy Challenge). Instructions for the easy task condition are presented below. For the moderately difficult and extremely difficult task conditions the words in quotations were replaced by the relevant words contained in brackets (all instructions were audiotaped).

"We will begin the second part of the experiment. As you were told before, in this experiment we are studying the performance and physiological responses of persons while working on easy tasks, moderately difficult tasks, and extremely difficult tasks. You will now be asked to begin the first task which most people find to be easy" (moderately difficult, extremely difficult).

The tasks you will work on are taken from the Wechsler Adult Intelligence Scale (Wechsler, 1955), a widely used IQ test. These scales correlate highly with overall IQ and are often used as quick measures of general intelligence. In the first test, I will read you a series of numbers, and as soon as I am through reading the numbers, your job will be to immediately repeat the numbers in reverse order -- that is, to say the series of numbers backwards. For example, if I said 7-3-9, you would say 9-3-7. There will be eight such problems and because you are in the easy condition (moderately difficult, extremely difficult), there will be three (five, seven) numbers in each problem. Our previous research has suggested that it is "very easy" to repeat three numbers backwards (moderately difficult for most people to repeat five digits backwards, extremely difficult for most people to repeat seven digits backwards).

I will now begin by saying the numbers. After each set, I will pause and then you should repeat the set backwards. Your responses will be picked up by the microphone in front of you and scored by the experimenter. Problem Number One: 5-2-3 (3-2-4-7-9, 1-7-5-6-2-9-4).

Ten problems of the appropriate level of difficulty were presented to the subject and his responses recorded. A sample data sheet is provided in Appendix E. During the last half of every task all physiological dependent measures were recorded. After the last problem of each task, the subject was again asked to complete the subjective arousal questions (Appendix F), except this time he was asked to indicate how he felt while working on the task. A 4 min rest period was observed between each of the trials to allow recovery from physiologic arousal elicited by each challenge.

Task A (Moderate Challenge). The text was followed the above format except that "moderately difficult" was substituted for "easy" and five digit sequences were presented.

Task A (Difficult Challenge). The text again followed the preceeding format except that "extremely difficult" was substituted for "moderately difficult" and seven digit sequences were presented.

Task B (Easy Challenge). Following the difficult digits recall task and a 4 min rest period, all subjects began the Block Design Tasks. Instructions for the easy task condition are presented below. For the moderately difficult task and extremely difficult task conditions, the words in quotations were replaced by the relevant words contained in brackets.

The task you will work on is actually a visuospatial test from the Wechsler Adult Intelligence Scale (Wechsler, 1955).

You see these blocks. They are all alike. On some sides they are red; on some, all white, and on some half red and half white. I am going to put them together to make a design. Watch me (four blocks will be used to make Design #1 and four blocks will subsequently be passed to the subject). Now without using your __________ (nondominant) arm make one just like this (if the subject fails, another design will be constructed). Most people find these tasks to be relatively easy.

Task B (Moderate Challenge). Most people find the next three designs to be moderately difficult. This time I would like for you to put the blocks together to make them look like this picture. Tell me when you have finished. (When the subject indicates he has finished or is at the end of the time limit, the blocks will be mixed up and he will be presented with the next design.) Designs 4-7 will be used during this phase. When the subject has completed Design #6, the experimenter will take out the five other blocks and say: now make one like this (Design #7) using all nine blocks; be sure to tell me when you have finished.

Task B (Difficult Challenge). Most people find the final designs (8-10) to be extremely difficult. Please indicate the second you finish the design.

TIME LIMITS:

Designs 1-3	60 s
Designs 4-6	60 s
Designs 7-10	120 s

Task B (Rest Phase). Subjects will be instructed to sit quietly and relax as in post-task (A). Recovery will be measured in the fourth minute of this 5-minute rest phase.

Debriefing

All subjects were sent a letter (Appendix G) describing the nature of the study and the experimental hypothesis. They were also given their Type score, their Self-Reported Reactivity score (ANSRI), and their resting blood pressure.

Results

One of the premises of this study was that physiological reactivity occurs in both Type A and Type B individuals and that it is this factor that increases individuals' vulnerability to CHD. The distribution of reactive and nonreactive individuals categorized by Type is presented in Table 1A and 1B. Reactives were defined as those subjects one standard deviation above the ANSRI mean in Table 1A and those subjects above the ANSRI median in Table 1B. Nonreactives were defined as those subjects one standard deviation below the ANSRI mean in Table 1A and those subjects below the median in Table 1B.

Table 1A

Subjects One Standard Deviation Above or Below the ANSRI Mean

	Reactive	Nonreactive	
Type A	6 24%	7 28%	13 52%
Type B	7 28%	5 20%	12 48%
Total	13 52%	12 48%	

The frequency of Type A (JAS$\geq$11) and Type B (JAS$\leq$5) subjects scoring one standard deviation above or below the ANSRI mean (Reactive: ANSRI $\geq$ 275; Nonreactive: ANSRI $\leq$ 168).

Table 1B

Subjects Scoring Above or Below the ANSRI Median

	Reactive	Nonreactive	
Type A	11 19.3%	13 22.8%	24 42.1%
Type B	16 28.1%	17 29.8%	33 57.9%
Total	27 47.4%	30 52.6%	

The frequency of Type A and Type B subjects scoring above or below the ANSRI median (ANSRI median = 228).

Chi-square analysis revealed no significant differences in cell size using either classification technique: $X^2(1, N = 25) = .37$, $p = .54$ for the one standard deviation criterion, and $X^2(1, N = 57) = .04$, $p = .84$ for the median split criterion. These data suggest that there is at least no self-perceived difference in psychophysiologic reactivity between Type A and Type B subjects.

Pearson product-moment correlations between the Jenkins Activity Survey, the ANSRI, and the PPRS are presented in Table 2.

Table 2

Pearson Product-Moment Correlations Between: JAS, ANSRI, and PPRS

	JAS	ANSRI	PPRS
JAS	1.000	.002	-.101
ANSRI	.002	1.000	.406*
PPRS	-.101	.406*	1.000

*p < .001

Again, there appeared to be no relationship between Type A/B scores and perceived degree of psychophysiologic reactivity as defined by either measure of reactivity. However, as expected, there was a significant correlation between the PPRS and the ANSRI (r = .406, p <.001). These two instruments are assumed to measure the same construct. However, they differ in that specific stressful situations are presented in the PPRS and subjects rate the perceived arousal to single physiologic indices such as heart rate, whereas the ANSRI requires the subject to imagine two intensely stress provoking incidents and rate 51 separate physiologic indices for each. This method variance may account for the low-moderate correlation between the two measures.

Pearson correlation coefficients were also calculated to examine the relationships between the Jenkins Activity Survey, the Autonomic Nervous System Response Inventory, and all five physiologic dependent measures (systolic blood pressure, diastolic blood pressure, heart rate, electrodermal response, and overall cardiovascular response labeled OPHYS which was the sum of SBP, DBP, and HR). Results are presented in Table 3.

Table 3

Pearson Product-Moment Correlations Between: JAS, PPRS, ANSRI, and all Dependent Variables

	JAS	PPRS	ANSRI
SBP	.075	.346*	.475*
DBP	.034	-.110	.001
HR	.077	.052	.223
EDR	.261	.114	.147
OPHYS	.085	.150	.334*

JAS = Jenkins Activity Survey; PPRS = Pacific Psychophysiologic Reactivity Scale; ANSRI = Autonomic Nervous System Response; SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure; HR = Heart Rate; EDR = Electrodermal Response; OPHYS = Overall Cardiovascular Response

* $p < .001$

Similar to its lack of relationship with self-reported degree of physiologic reactivity, the Jenkins Activity Survey showed no correlation with actual physiologic behavior during tasks. The slight positive correlation with electrodermal response may be due to higher level of anticipation and apprehension in Type As compared to Type Bs prior to beginning the first task. The nature of electrodermal activity as it relates to this and other findings will be explained in the discussion section. On the other hand, both the PPRS and the ANSRI were significantly correlated with systolic blood pressure ($p < .001$). The ANSRI was also correlated with overall cardiovascular response, indicating that both the PPRS and the ANSRI are more closely associated with certain critical physiologic events than is the Jenkins Activity Survey.

Task Difficulty (Manipulation Check)

Before testing to determine whether subjects responded with more arousal as a function of type or reactivity, it was necessary to determine whether subjects perceived tasks as differing in difficulty. The mean scores for perceived difficulty are presented in Table 4 followed by a series of related groups t-tests which were performed to determine significant differences across tasks and levels of challenge.

Table 4

Subjects Mean Ratings of Perceived Task Difficulty

Condition	Mean	Standard Deviation
1. Pretask Rest	1.533	1.008
2. Easy Digits	2.500	1.383
3. Moderate Digits	6.500	1.432
4. Difficult Digits	7.900	1.423
5. Easy Blocks	1.833	1.020
6. Moderate Blocks	2.967	1.650
7. Difficult Blocks	5.733	1.721
8. Posttask Rest	2.033	1.426

Conditions Compared	t Value	2-Tail Probability
1,2	3.09	$p<.01$
2,3	11.00	$p<.01$
3,4	3.80	$p<.01$
4,5	18.98	$p<.01$
5,6	3.20	$p<.01$
6,7	6.36	$p<.01$
7,8	9.07	$p<.01$
2,5	2.12	NS
3,6	8.86	$p<.01$
4.7	5.32	$p<.01$

1. Scale is 1= very easy to 9 = very difficult. Related groups t-tests are presented below with comparisons between successive conditions (1-8) and between comparable levels of challenge (easy-easy, moderate-moderate, etc.) df = 26

There was a significant difference in perceived task difficulty at each successive challenge condition in the expected direction. That is, challenges were perceived as increasing in level of difficulty. However, the block design task was considered to be less challenging than the digits recall task overall. In fact, the most difficult block design task was judged to be less challenging than either the moderate or the difficult digits recall tasks.

Analyses of Variance

Separate 2x2x2x3 (Type A/B x Reactivity High/Low x Task x Challenge) analyses of variance were conducted on each of the five physiologic dependent variables. Graphs of mean values across both tasks and all levels of challenge and ANOVA source tables are presented in Figures 5 through 19. Pairwise comparisons using Dunn's procedure (Kirk, 1982) were performed on all significant main and interaction effects.

Systolic Blood Pressure (Figures 5 - 7). There was no significant Type A/B effect for systolic blood pressure $F(1, 26) = .403$, $p > .10$. However, there was a significant Reactivity main effect $F(1, 26) = 13.789$, $p < .01$, such that reactives had higher systolic blood pressure across levels of challenge. Furthermore, the mean SBP for reactives exceeded the clinically hypertensive range of 140 mm Hg during five of the six challenge conditions. The impact of this finding will be discussed later.

There was also a significant challenge main effect $\underline{F}(2, 52) = 17.533$, $\underline{p} < .01$, such that SBP during difficult challenges was significantly higher that SBP during easy challenges $\underline{t}(26) = 2.85$, $\underline{p} < .01$. This finding parallels those of Holmes, McGilley, and Houston (1984) and provides further confirmation of differences in manipulated levels of challenge.

There were no other significant main effects or interaction effects. The Type X Reactivity Interaction which was expected, assuming that Type A/B did contribute to physiologic arousal was not significant at the .01 level.

Table 5
ANOVA For SBP:
TYPE x PHYS x TASK X CHALLENGE

Source of Variation	Sum of Squares	DF	Mean Square	F
TYPE (T)	218.700	1	218.700	.403
PHYS (P)	7475.556	1	7475.556	13.789*
TYPE x PHYS	1687.500	1	1687.500	3.113
Ss within T,P	14095.780	26	542.145	-
TASK (K)	153.089	1	153.089	3.280
TYPE x K	11.615	1	11.615	.249
PHYS x K	10.756	1	10.756	.230
TYPE x PHYS x K	15.170	1	15.170	.325
K x Ss within T,P	1213.370	26	46.670	-
CHALLENGE (C)	1360.533	2	680.267	17.533*
TYPE x C	30.606	2	15.303	.394
PHYS x C	185.378	2	92.689	2.389
TYPE x PHYS x C	16.650	2	8.325	.215
C x Ss within T,P	2017.500	52	38.800	-
K x C	254.178	2	127.089	3.012
TYPE x K x C	34.146	2	17.073	.404
PHYS x K x C	6.578	2	3.289	.078
TYPE x PHYS x K X C	.857	2	.429	.010
K x C x Ss within T,P	2194.240	52	42.200	-
TOTAL	30982.20	179		

* $p<.01$

Figure 6a

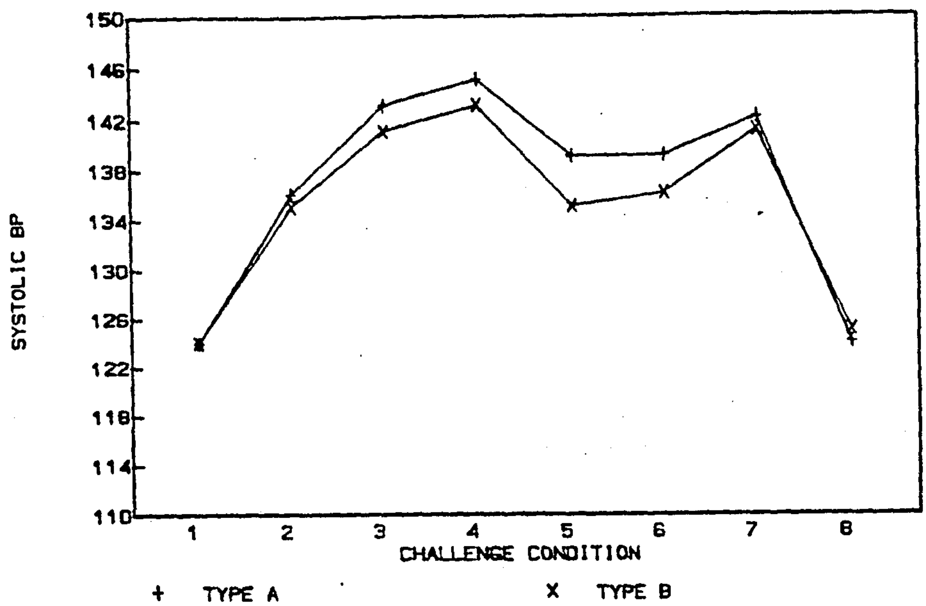
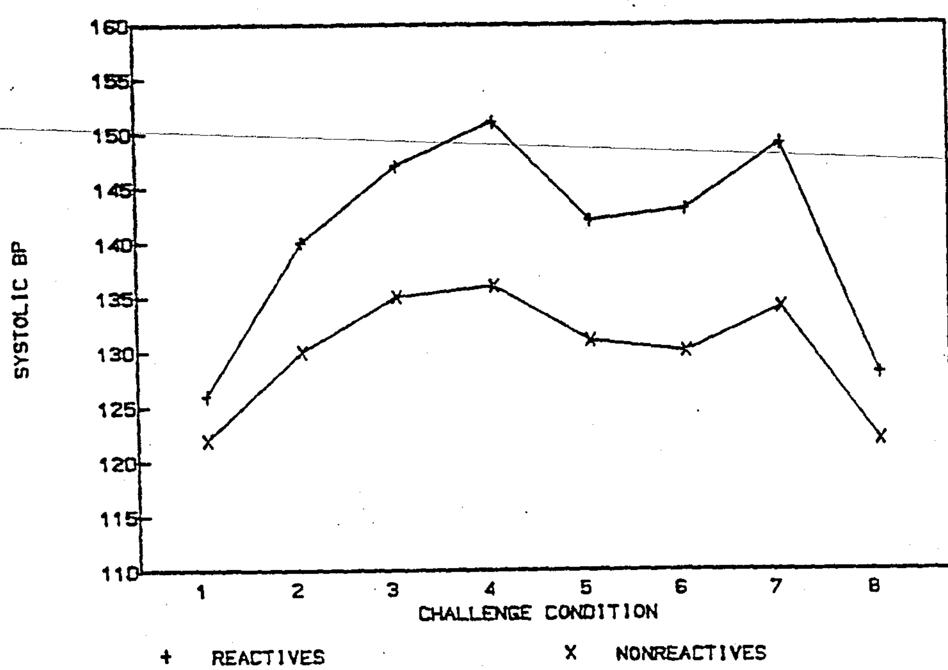
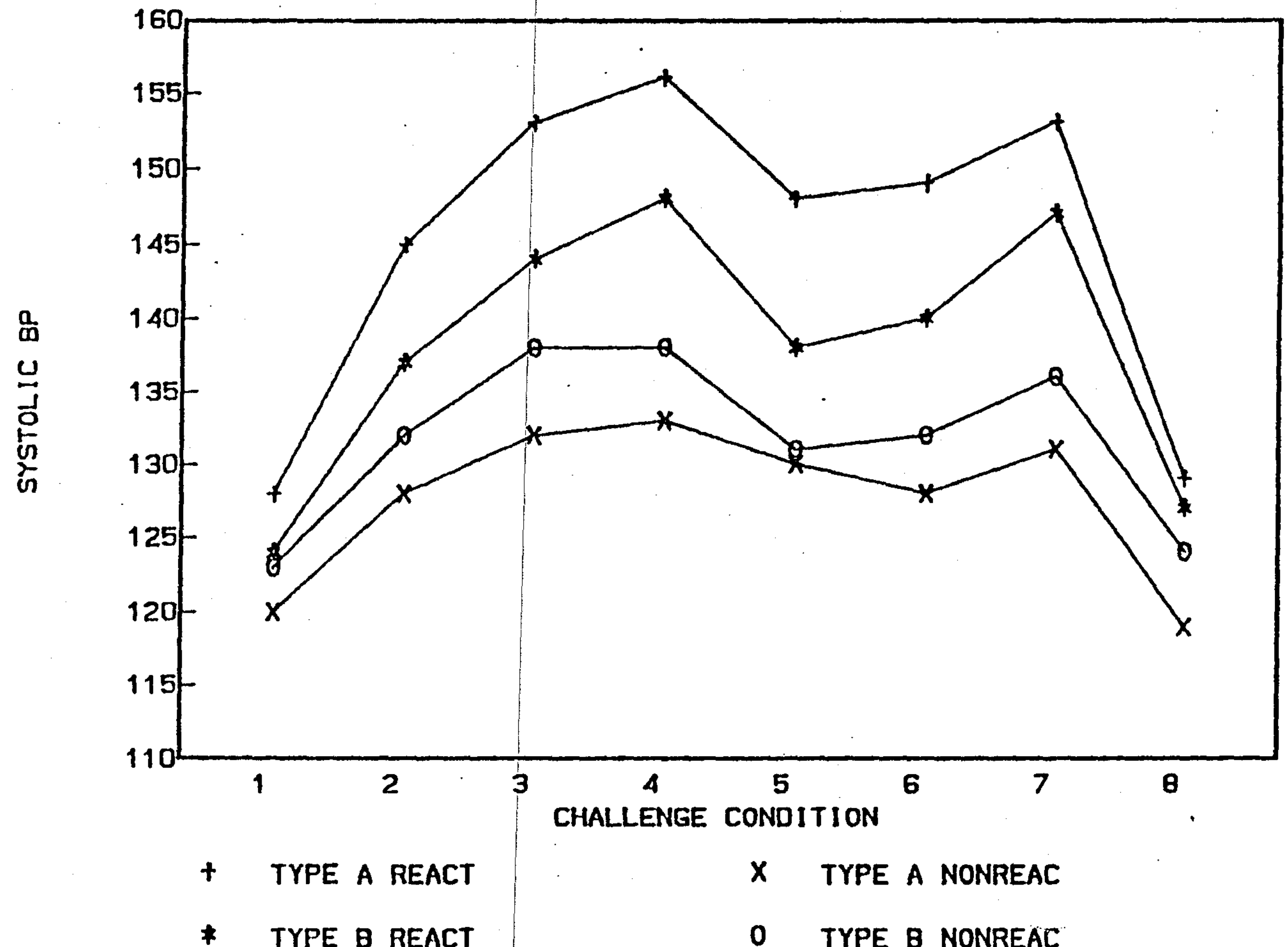


Figure 6b



Mean Systolic Blood Pressure for Type As and Type Bs (Figure 6a) and Reactives and Nonreactives (Figure 6b) across all levels of challenge.

Table 7



<u>Mean Systolic Blood Pressure for Reactive and Nonreactive Type As and Type Bs across all levels of challenge</u>.

Diastolic Blood Pressure (Figures 8 - 10). Only the challenge main effect $F(2, 52) = 18.628$, $p<.01$ and the Task x Challenge interaction $F(2, 52) = 6.414$, $p<.01$ were significant for diastolic blood pressure. Like SBP, the significant difference for DBP occurred between the easy and difficult challenges $t(26) = 3.69$, $p<.01$ such that DBP was higher for the difficult challenges compared to the easy ones.

The Task X Challenge interaction corroborated the perceived differences between the digits recall and block design tasks. That is, the elevation of DBP which approached significance during the digits recall task occurred between the easy and moderate challenge $t(26) = 2.38$, $p<.05$, whereas the significant elevation of DBP during the block design task occurred between the easy and difficult challenge $t(26) = 2.98$, $p<.01$. This finding is consistent with the subject's subjective evaluation that the difficult blocks task is about as demanding as the moderate digits recall task.

Table 8

ANOVA For DBP:
TYPE x PHYS x TASK X CHALLENGE

Source of Variation	Sum of Squares	DF	Mean Square	F
TYPE (T)	4.408	1	4.408	.012
PHYS (P)	.356	1	.356	.001
TYPE x PHYS	2256.223	1	2256.223	6.052
Ss within T,P	9692.324	26	372.780	-
TASK (K)	128.356	1	128.356	2.036
TYPE x K	2.408	1	2.408	.038
PHYS x K	235.756	1	235.756	3.740
TYPE x PHYS x K	3.675	1	3.675	.058
K x Ss within T,P	1639.139	26	63.040	-
CHALLENGE (C)	1282.711	2	641.356	18.628*
TYPE x C	213.539	2	106.769	3.101
PHYS x C	125.378	2	62.689	1.821
TYPE x PHYS x C	125.446	2	62.723	1.822
C x Ss within T,P	1790.259	52	34.430	-
K x C	384.044	2	192.022	6.414*
TYPE x K x C	52.817	2	26.408	.822
PHYS x K x C	81.111	2	40.556	1.355
TYPE x PHYS x K x C	107.917	2	53.958	1.802
K x C x Ss within T,P	1556.780	52	29.940	-
TOTAL	19682.644	179		

* $p < .01$

Figure 9a

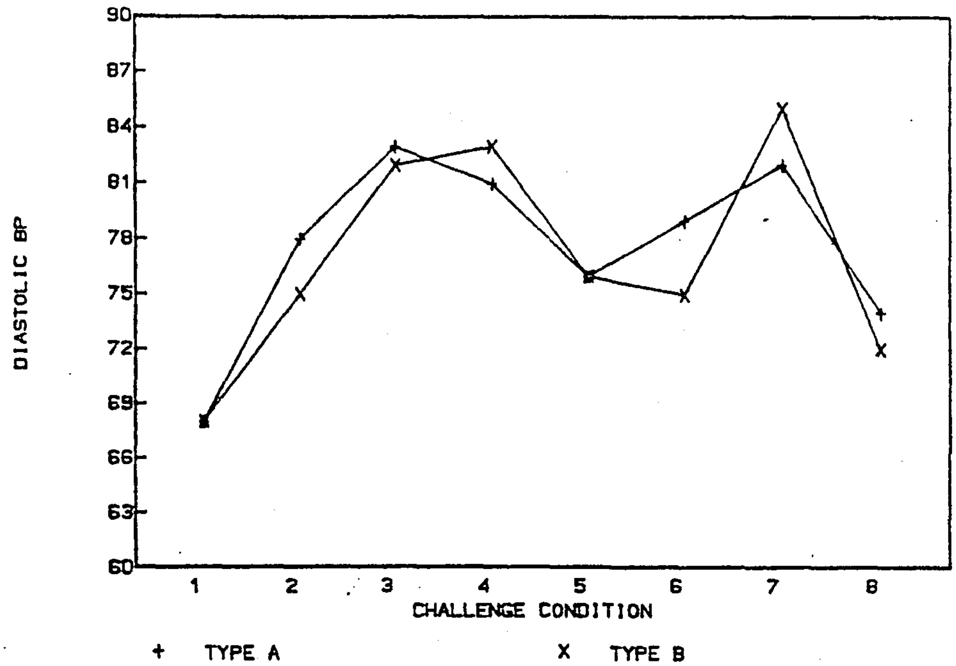
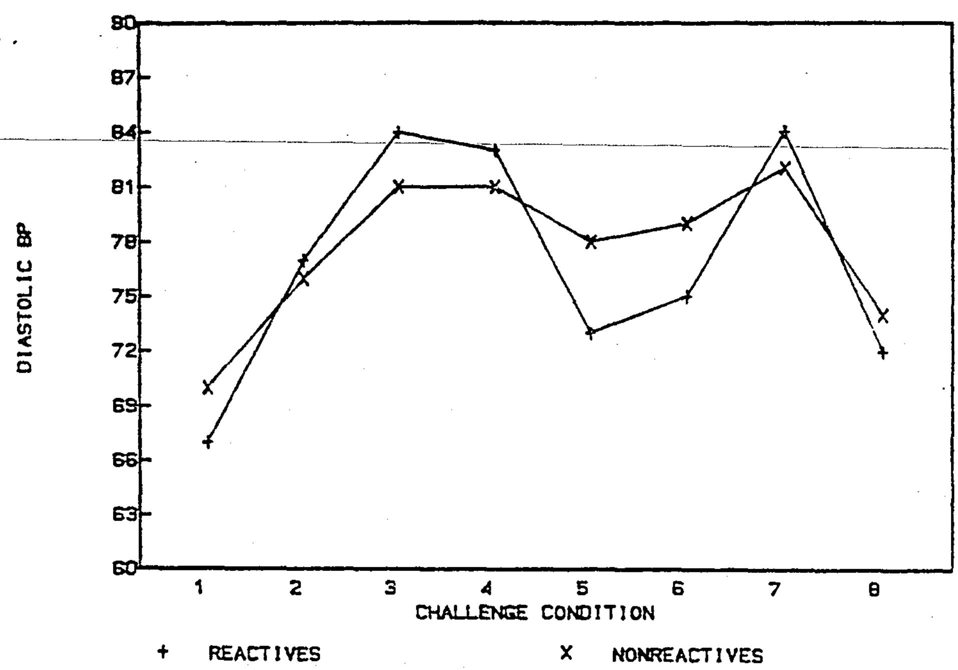
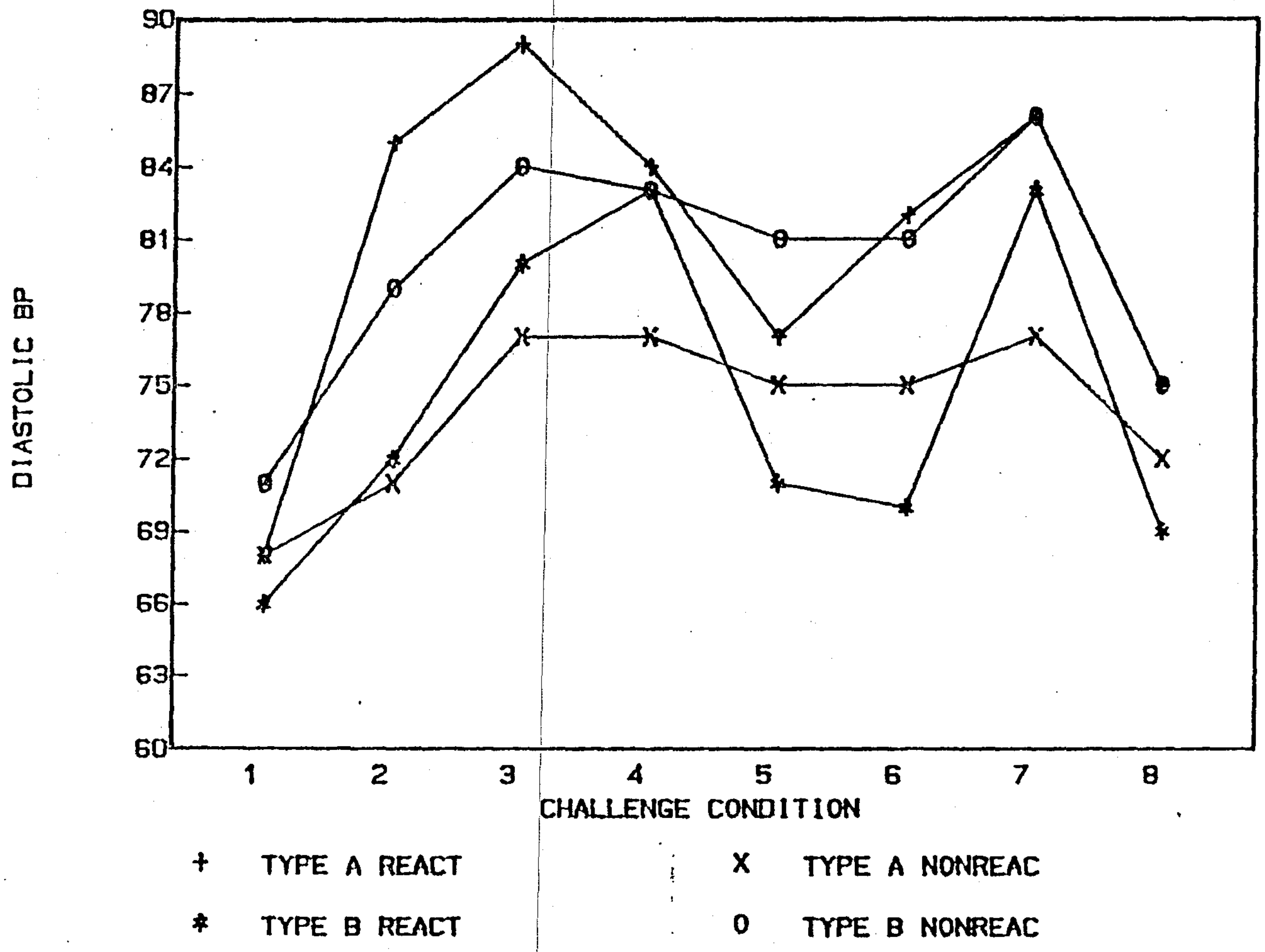


Figure 9b



Mean Diastolic Blood Pressure for Type As and Type Bs (Figure 9a) and Reactives and Nonreactives (Figure 9b) across all levels of challenge.

Figure 10



Mean Diastolic Blood Pressure for Reactive and Nonreactive Type As and Type Bs across all levels of challenge.

<u>Heart Rate (Figures 11 - 13)</u>. There were no significant main effects or interaction effects for heart rate.

Table 11

<u>ANOVA For Heart Rate:</u>
<u>TYPE x PHYS x TASK x CHALLENGE</u>

Source of Variation	Sum of Squares	DF	Mean Square	F
TYPE (T)	255.208	1	255.208	.420
PHYS (P)	785.422	1	785.422	1.293
TYPE x PHYS	830.379	1	830.379	1.367
Ss within T,P	15793.602	26	607.446	-
TASK (K)	341.689	1	341.689	3.985
TYPE x K	27.075	1	27.075	.316
PHYS x K	82.689	1	82.689	.964
TYPE x PHYS x K	72.075	1	72.075	1.141
K x Ss within T,P	1642.375	26	63.168	-
CHALLENGE (C)	76.844	2	38.422	.608
TYPE x C	22.739	2	11.369	.180
PHYS x C	56.311	2	28.156	.446
TYPE x PHYS x C	72.735	2	36.368	.576
C x Ss within T,P	3283.222	52	63.139	-
K x C	23.511	2	11.756	.209
TYPE x K x C	6.572	2	3.286	.058
PHYS x K x C	218.711	2	109.356	1.949
TYPE x PHYS x K x C	9.872	2	4.936	.088
K x C x Ss within T,P	2916.727	52	56.091	-
TOTAL	27101.444	179		

*$p < .01$

Figure 12a

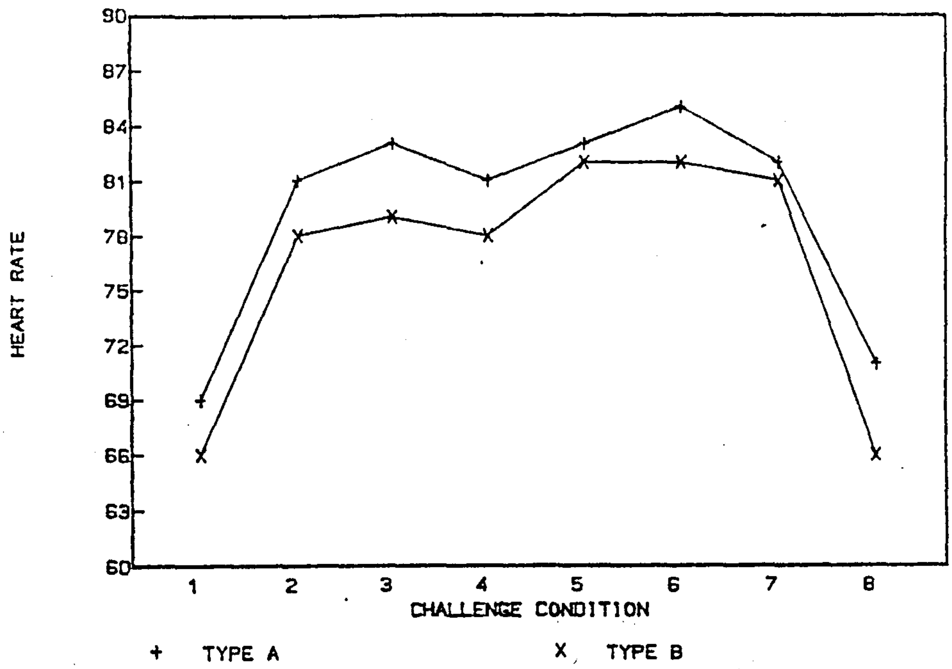
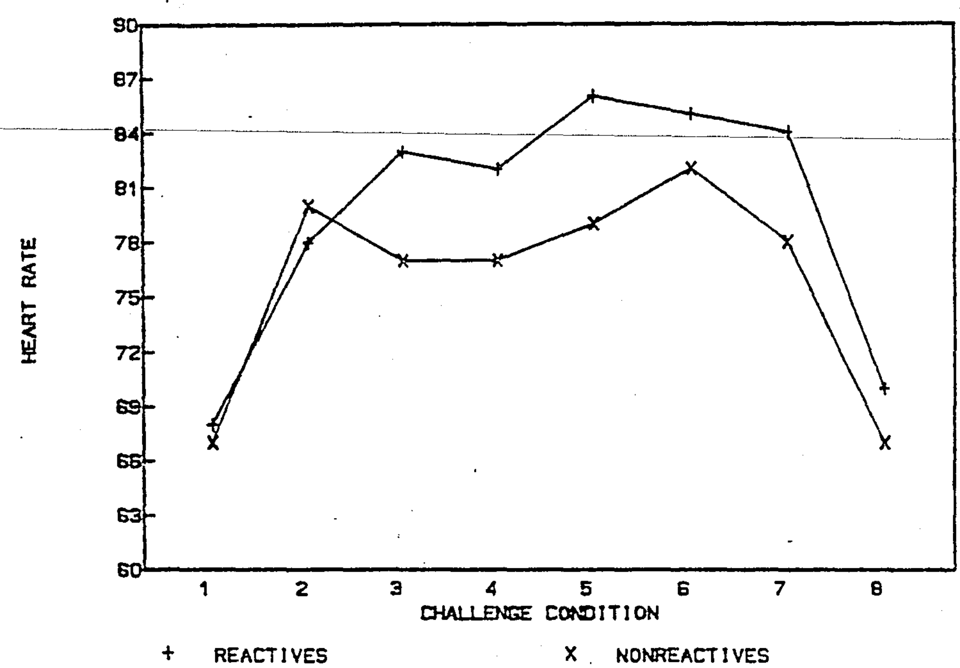
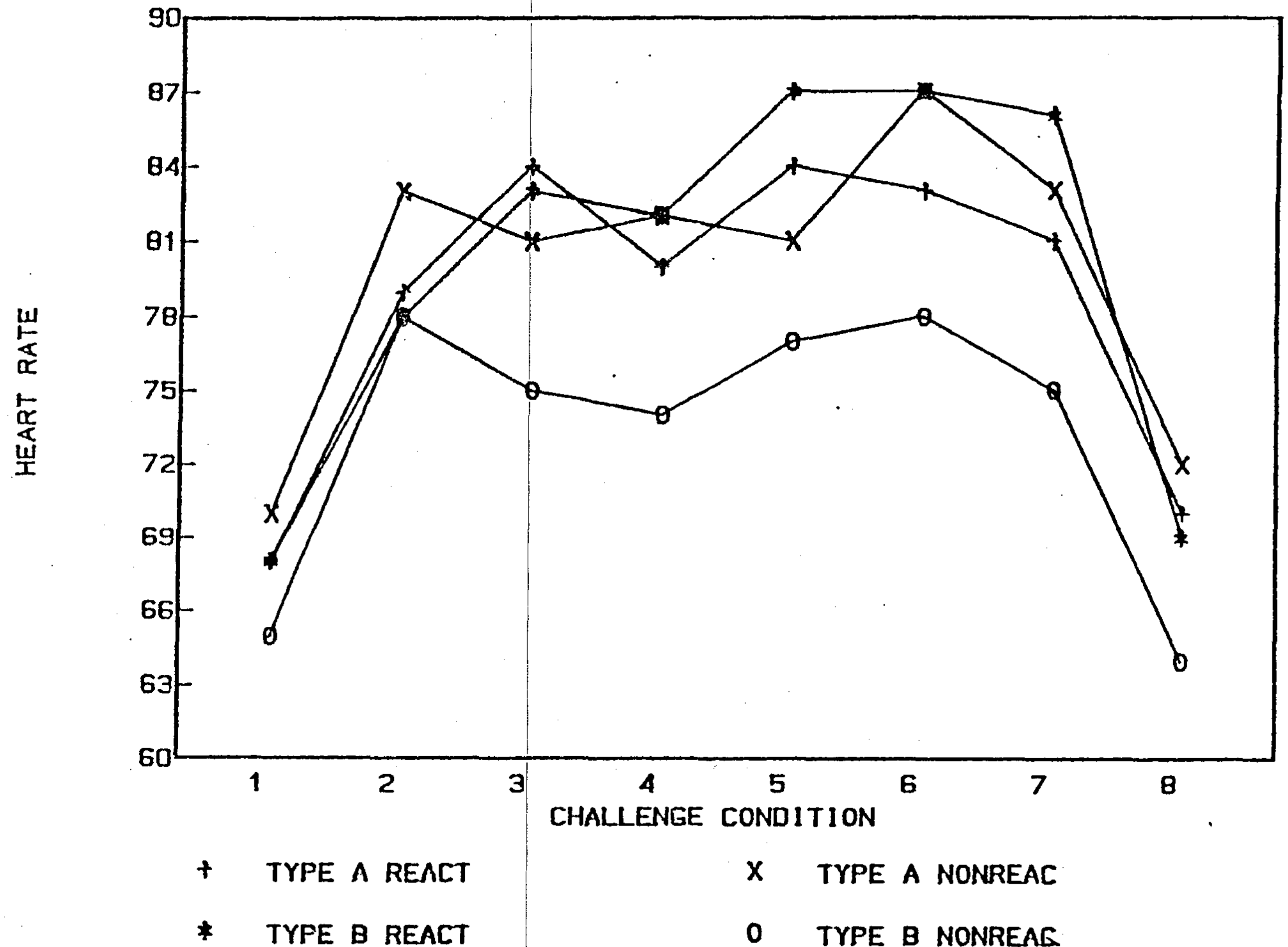


Figure 12b



Mean Heart Rate for Type As and Type Bs (Figure 12a) and Reactives and Nonreactives (Figure 12b) across all levels of challenge.

Figure 13



Mean Heart Rate for Reactive and Nonreactive Type As and Type Bs across all levels of challenge.

<u>Electrodermal Response (Figures 14 - 16)</u>. There was a significant task main effect $F(1, 26) = 39.707$, $p<.01$ and challenge main effect $F(2, 52) = 9.560$, $p<.01$ for electrodermal response. The challenge pairwise comparison effects were not significant at the .01 level. Electrodermal response was higher during the first task (digits recall) than during the second (block design) as it was higher during the first challenges compared to later challenges, although not significantly so. This effect varies as a function of reactivity such that there was a Reactivity x Task x Challenge interaction effect $F(2, 52) = 5.528$, $p<.01$. As can be seen in figure 15, both reactives and nonreactives experience an initial burst of EDR followed by gradual habituation. This was especially pronounced in reactives. The effect appears to be the EDR orientation response which is well described by Edelberg (1972) and is particularly strong for reactives. This effect will be addressed in the discussion section.

Table 14

ANOVA For EDR:
TYPE x PHYS x TASK x CHALLENGE

Source of Variation	Sum of Squares	DF	Mean Square	F
TYPE (T)	46.542	1	46.542	4.134
PHYS (P)	8.617	1	8.617	.765
TYPE x PHYS	7.187	1	7.187	.638
Ss within T,P	293.524	26	11.289	-
TASK (K)	96.092	1	96.092	39.713*
TYPE x K	.241	1	.241	.100
PHYS x K	13.787	1	13.787	5.698
TYPE x PHYS x K	.000	1	.000	.000
K x Ss within T,P	62.911	26	2.420	-
CHALLENGE (C)	24.454	2	12.227	9.376*
TYPE x C	5.154	2	2.577	1.976
PHYS x C	6.769	2	3.384	2.595
TYPE x PHYS x C	2.182	2	1.091	.837
C x Ss within T,P	66.495	52	1.279	-
K x C	11.771	2	5.886	5.082
TYPE x K x C	.866	2	.433	.374
PHYS x K x C	12.805	2	6.402	5.528*
TYPE x PHYS x K x C	.809	2	.445	.384
K x C Ss within T,P	60.754	52	1.168	-
TOTAL	721.042	179		

* P<.01

Figure 15a

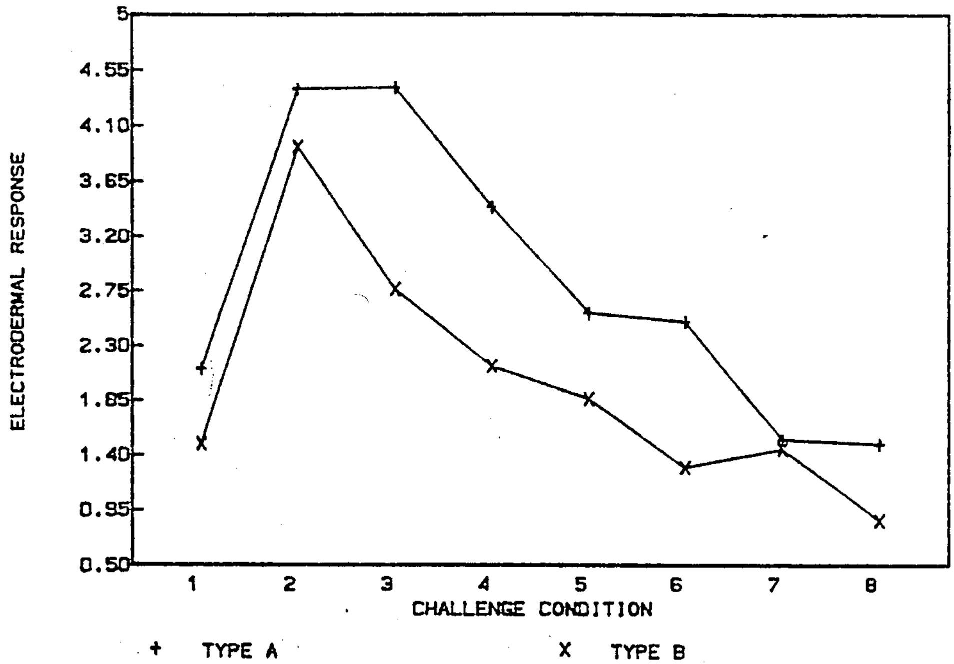
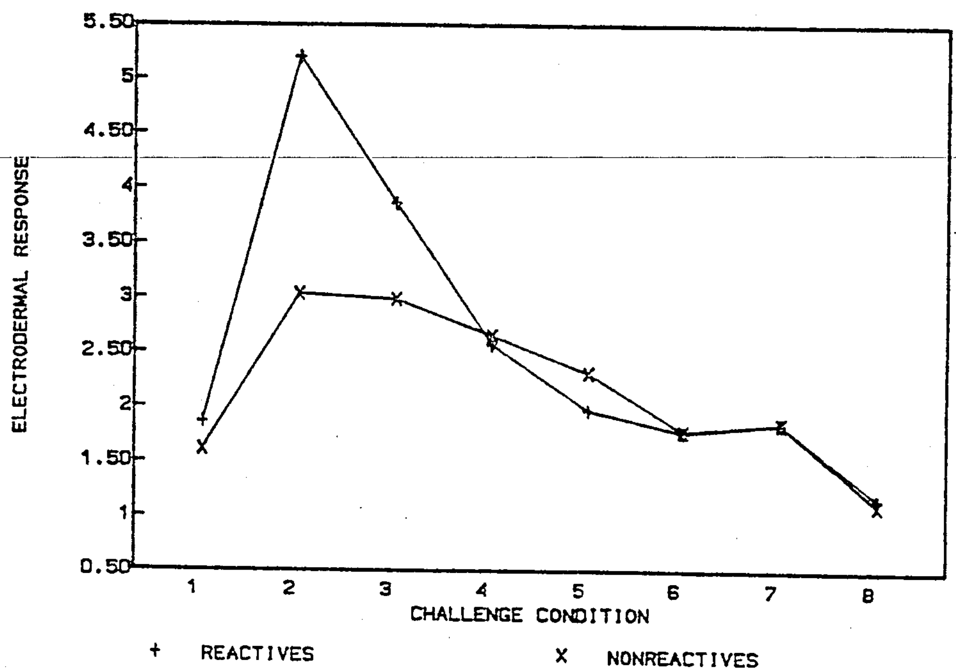
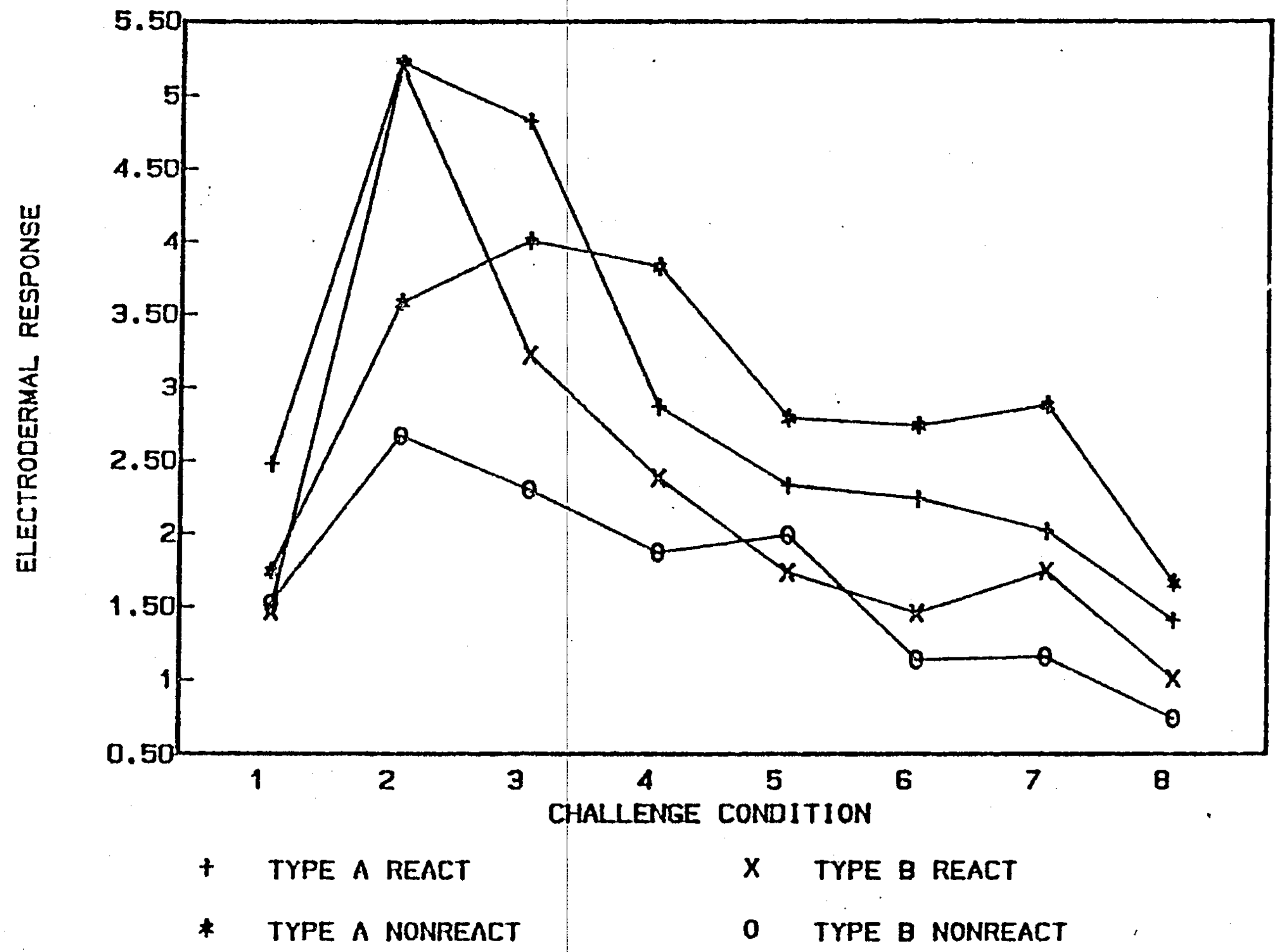


Figure 15b



Mean Electrodermal Response (microvolts/sec.) for Type As and Type Bs (Figure 15a) and Reactives and Nonreactives (Figure 15b) across all levels of challenge.

Figure 16



<u>Mean Electrodermal Response for Reactive and Nonreactive Type As and Type Bs across all levels of challenge</u>.

Overall Cardiovascular Response (Figures 17 - 19). Only the Challenge main effect $F(2, 52) = 14.759$, $p<.01$ was significant for overall cardiovascular response. However, the multiple comparison effects were not significant at the .01 level.

Table 17

ANOVA For Overall Cardiovascular Response:
TYPE x PHYS x TASK x CHALLENGE

Source of Variation	Sum of Squares	DF	Mean Square	F
TYPE (T)	1080.000	1	1080.000	.361
PHYS (P)	12971.022	1	12971.022	4.336
TYPE x PHYS	3571.570	1	3571.570	1.194
Ss within T,P	77772.881	26	2291.265	-
TASK (T)	27.222	1	27.222	.094
TYPE x K	11.204	1	11.204	.039
PHYS x K	8.889	1	8.889	.031
TYPE x PHYS x K	204.537	1	204.537	.706
K x Ss x within T,P	7532.524	26	289.712	-
CHALLENGE (C)	4973.733	2	2486.867	14.759*
TYPE x C	405.739	2	225.369	1.337
PHYS x C	965.511	2	482.756	2.865
TYPE x PHYS x C	394.424	2	197.212	1.170
C x Ss within T,P	8764.978	52	168.557	-
K x C	935.644	2	467.882	2.426
TYPE x K x C	77.846	2	38.923	.202
PHYS x K x C	294.711	2	147.356	.764
TYPE x PHYS x K x C	101.280	2	50.640	.263
K x C x Ss within T,P	10012.471	52	192.547	-
TOTAL	130179.00	179		

* $p<.01$

Figure 18a

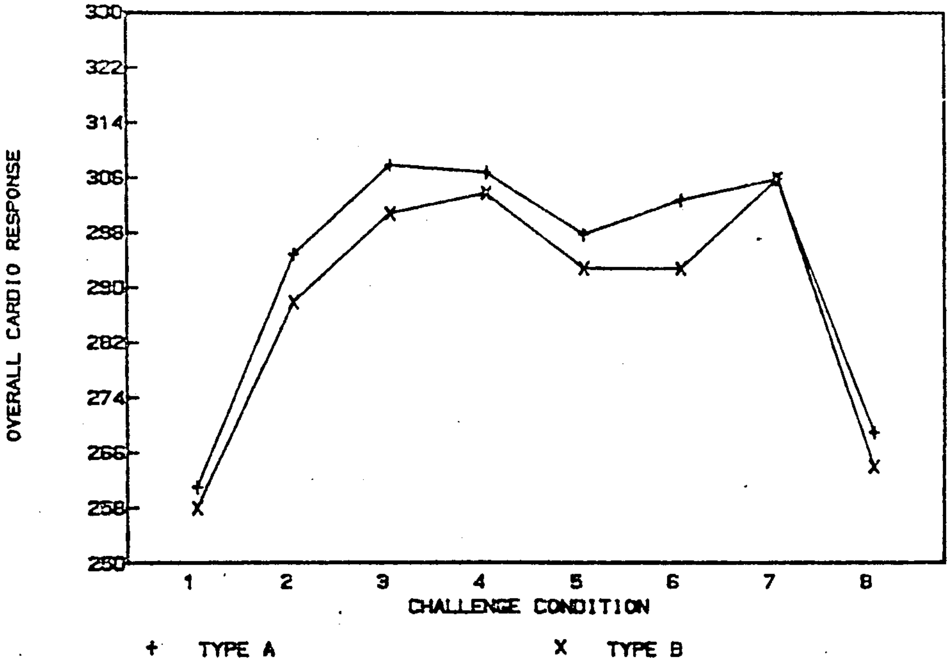
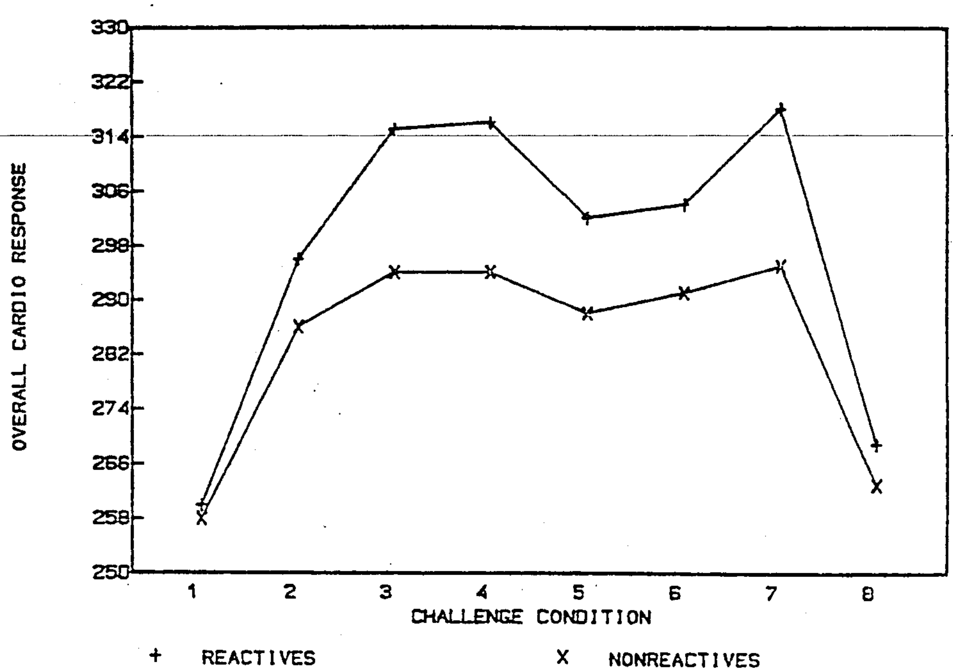
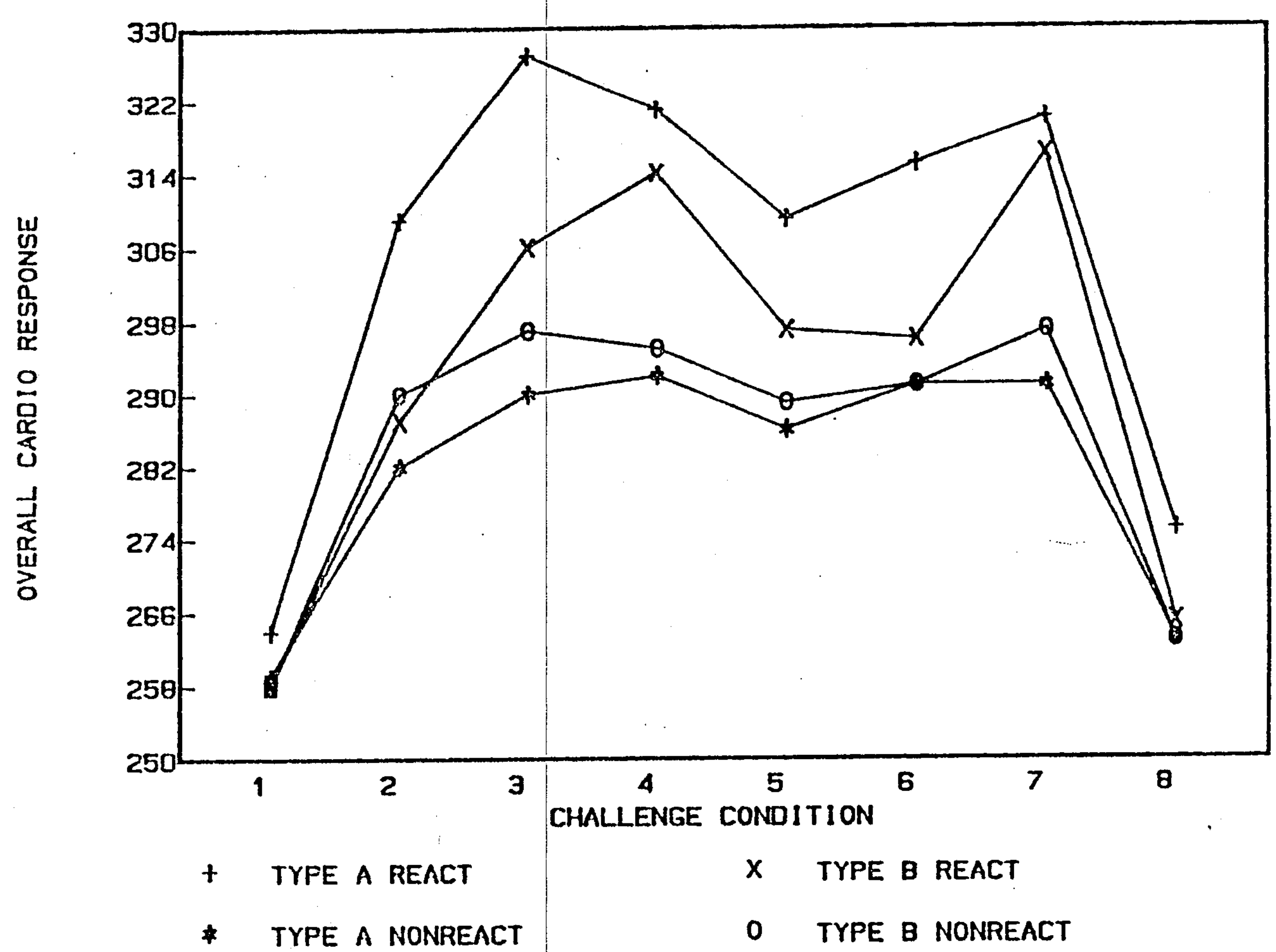


Figure 18b



Mean Cardiovascular Response for Type As and Type Bs (Figure 18a) and Reactives and Nonreactives (Figure 18b) across all levels of challenge.

Figure 19



Mean Cardiovascular Response for Reactive and Nonreactive Type As and Type Bs across all levels of challenge.

Exploratory Data Analysis

The significant Reactivity main effect for systolic blood pressure and the overall pattern of elevated physiologic response by reactives led to an investigation of the degree to which the best combination of predictor variables could maximize differences between reactives and nonreactives. Four separate Discriminant Function Analyses were performed on the data. In the first two, the classified groups were reactives vs. nonreactives. In the second two, the same set of analyses were carried out on Type As vs. Type Bs to confirm the apparent lack of predictability of these groups using physiologic measures. Two discriminant analyses were performed on each set of groups because different predictor variables were entered into the equations.

In the first discriminant analysis, systolic blood pressure, diastolic blood pressure, and heart rate were entered as predictor variables. EDR was not included because it is not directly related to cardiovascular reactivity. Each of the eight challenge conditions from pretask rest through the digits recall and block design tasks to posttask rest were considered discrete events so that eight values for each of the three physiologic variables comprised the total pool of 24 predictor variables. The SPSS Stepwise Discriminant procedure using the minimum Wilk's Lambda criterion (which produces the largest multivariate F) was chosen for this and subsequent analyses because there was no a priori reason for ordering entry of variables into the discriminating equations (Tabachnick & Fidell, 1983).

A single discriminant function was calculated with highly significant discriminating power $X^2(5) = 20.755$, $p<.001$. The loading matrix of correlations between predictor variables and the pooled within-groups correlations among predictors is presented in Table 20.

Table 20

Results of Discriminant Function Analysis of Physiologic Variables

Groups are Reactive vs. Nonreactives

Predictor Variable	Correlations of Predictor Variables With Discriminant Function	Pooled Within-Groups Correlations Among Predictors			
		SBP5	DBP5	DBP7	DBP8
SBP1 = Pretask Resting SBP	-.479	.653	.482	.647	.553
SBP5 = Easy Blocks SBP	1.172		.353	.347	.453
DBP5 = Easy Blocks DBP	-.779			.692	.490
DBP7 = Difficult Blocks DBP	1.053				.698
DBP8 = Posttask Resting DBP	- .755				
Eigenvalue	1.257				
Canonical R	.746				

Among the five predictor variables which made up the function, only SBP during the easy block design task produced a significant univariate $\underline{F}$ value $\underline{F}(1,28) = 12.93$, $\underline{p}<.01$. In all six of the nonresting challenge conditions, the univariate F for systolic blood pressure was significant at the .01 level. However, since these values had high intercorrelations, they contributed relatively little to the discriminant function. That is, once one variable was selected, the other SBP variables contributed relatively little new information. Of the variables that did make up the discriminant function, diastolic blood pressure during the easy block design and at posttask rest were higher for nonreactives than reactives, whereas systolic blood pressure during the block design task and diastolic blood pressure during the difficult block design task were higher for reactives than for nonreactives. As the univariate F-tests indicate, these variables contribute little information independently, but in combination with all other predictors, they are able to discriminate between reactives and nonreactives.

Classification results are presented in Table 21. As can be seen in this table, the discriminant function made up of physiologic variables successfully classifies 12/15 reactives and 13/15 nonreactives for a cumulative percent classification of 83.33.

Table 21

Classification Results From Discriminant Analysis #1

Actual Group	No. of Cases	Predicted Group Membership 1	2
Group 1 Reactive	15	12 80.0%	3 20.0%
Group 2 Nonreactive	15	2 13.3%	13 86.7%

Percent of "Grouped" cases correctly classified: 83.33%

In the second discriminant analysis, the subjective appraisal of physiologic arousal (SPHY = Sum of scaled ratings of heart rate, respiration rate, and sweat gland response) and the overall cardiovascular response (OPHYS previously defined as the sum of heart rate, SBP, and DBP) were entered as predictor variables. Again, each of the eight challenge conditions were considered separately making up a total of 16 predictor variables.

A single discriminant function was calculated with significant discriminating power $X^2(3) = 14.350$, $\underline{P}<.005$. The loading matrix of correlations between predictor variables and the pooled within-groups correlations among predictors is presented in Table 22.

Table 22

Results of Discriminant Function Analysis of Subjective Arousal and Overall Cardiovascular Arousal

Groups are Reactive vs. Nonreactives

Predictor Variable	Correlations of Predictor Variables With Discriminant Function	Pooled Within-Groups Correlations Among Predictors	
		SPHY8	OPHYS4
SPHY4 = Subjective Arousal During Difficult Digits Recall	.863	.486	.059
SPHY8 = Subjective Arousal During Posttask Rest	-.415		.226
OPHYS4 = Overall Cardiovascular Response During Difficult Digits Recall	.817		
Eigenvalue	.719		
Canonical R	.647		

In this analysis the variables which, in combination with all others, contribute most to discriminating between reactives and nonreactives are subjective appraisal of physiologic response and overall cardiovascular response during the extremely difficult digits recall backwards task, and subjective physiologic response at rest.

As can be seen in the classification results presented in Table 23, the discriminant function made up of only three variables (one at posttask rest and two during the most difficult digits recall challenge) can successfully classify the same number of individuals as in the first discriminant analysis, namely 83.33%.

Table 23

Classification Results From Discriminant Analysis #2

Actual Group	No. of Cases	Predicted Group Membership 1	2
Group 1 Reactive	15	12 80.0%	3 20.0%
Group 2 Nonreactive	15	2 13.3%	13 86.7%

Percent of "Grouped" cases correctly classified: 83.33%

Neither discriminant analysis #3, using physiologic variables only, nor discriminant analysis #4, using the above combination of subjective and objective physiologic responses as predictor variables was sufficient to produce a function that could discriminate between Type As and Type Bs at the .01 level.

Discussion

This investigation produced several findings of interest. First, there was equal distribution of reactivity among Type As and Type Bs indicating no relationship between the Type A behavior pattern and perceived experience of physiologic reactivity as assessed by the ANSRI and the PPRS. In addition, there was no relationship between the Jenkins Activity Survey and actual physiologic measures during conditions of challenge. This is curious since the proposed mechanism linking Type A to coronary heart disease is, to a large extent, physiologic reactivity which results initially in arterial tears and ultimately in arteriosclerosis.

Secondly, the PPRS and the ANSRI were correlated and probably measure the same construct. Both correlate highly with systolic blood pressure which supports the contention that they are measures of physiologic reactivity. In contrast, as was stated previously, the Jenkins Activity Survey was not related to actual physiologic behavior.

The significant positive correlations between the ANSRI and both systolic blood pressure and overall cardiovascular arousal are noteworthy. The ANSRI appears to provide relevant information about two variables which have direct impact on cardiovascular fitness. Clearly, if it is possible through a self-report measure to screen individuals who may be at-risk for cardiovascular trauma, preventive measures might be taken at a very early stage to avoid pathogenesis.

The PPRS also correlated significantly with systolic blood pressure. This finding contributes to the construct validity of the PPRS and corroborates the ANSRI evidence. Both measures appear to provide far better information about actual physiologic events which may be involved in the cardiovascular disease process than does the Jenkins Activity Survey.

Analyses of variance revealed that reactives had reliably higher systolic blood pressure across challenge conditions than did nonreactives. The differences were large and clinically significant. During five of the six challenge conditions, the mean SBP of reactives exceeded 140 mm Hg which is the lower limit of the hypertensive range (Hassett, 1978). To the extent that reactives experience repeated elevations of SBP above this threshold level, their labile hypertension may become fixed and "essential."

These data suggest that Reactivity alone may predict systolic blood pressure and that Type A/B adds no relevant information to that prediction. Holmes et al. (1984) did obtain a Type A/B effect for systolic blood pressure at the extreme challenge condition of the digits recall task which was not replicated in the present study. However, Holmes et al. reported a very small difference between Type As and Bs (*p* = .03; M_s = 132.91 mm Hg vs. 128.23 mm Hg). They also tested the effect in the absence of a significant main effect or interaction effect, using a higher alpha level than in this study. Further, no a priori prediction was made to justify the statistical method employed.

Like the Holmes, McGilley, and Houston (1984) study, Type As and Bs did not differ in their diastolic blood pressure, heart rate, or electrodermal activity across tasks or challenges. This finding is also consistent with several previous studies cited by Holmes (1983). Unfortunately the Reactivity variable was not sufficient to detect differences in these physiologic behaviors at the .01 level either. Further refinement of the ANSRI or another measure of reactivity may lead to subscales of self-report items which reliably predict DBP and heart rate as the current ANSRI covaries with SBP. Electrodermal response may simply vary as a function of adaptation to a novel stimulus. Edelberg (1972) describes electrodermal activity as a complex neurodermal system with neocortical and limbic contributions which are related to emotional response, arousal mechanisms, and orientation to a stimulus. These data follow such a description and appear to represent an apprehension-orientation response by all subjects, particularly reactives, to the initial challenge followed by a sloping decline across time, indicating adaptation.

The choice to measure electrodermal activity in future studies might be reconsidered in light of these and similar findings (Holmes, 1983). On the other hand, physiologic variables such as catecholamine secretion and free fatty acid content which both directly impinge on cardiovascular fitness might be added to SBP, DBP, and heart rate as dependent variables in reactivity/nonreactivity research.

Although diastolic blood pressure did not independently vary as a function of reactivity/nonreactivity, discriminant function analyses indicate that in combination with other variables, DBP contributes unique information which differentiates reactives from nonreactives. The exact nature of this contribution requires further investigation, and it should be noted that these preliminary results are based on a small sample size (N = 30). A larger sample, and more cardiovascular measures might provide a far better picture of the interrelationships among variables which are relevant to cardiovascular pathogenesis.

In general, where significant effects occurred, they were consistent across tasks and levels of challenge. The block design task was perceived to be less difficult than the digits recall task, but both elicited comparable arousal responses (except for EDR which was previously discussed). The block design task was included in the study to determine if reactivity is task specific. Apparently it is not, although order effects were not controlled for since all subjects experienced digits recall first and block designs second.

Taken together, the results of this study support the hypothesis that an organismic variable - psychophysiologic reactivity exists and is independent of Type A/B. Psychophysiologically reactive and nonreactive Type As and Type Bs exist in the population and are probably equally likely to be recruited for participation in, among other things, psychology experiments. To the extent that chance distributions of reactives and nonreactives occur in subject pools of Type As and Type Bs, there should be little to no Type A/B effect for physiologic dependent variables. However, selection biases and sample size restrictions may inevitably lead to Type I errors (i.e., deciding incorrectly that the alternative hypothesis is supported). Holmes (1983) reviewed 19 studies which supported the hypothesis that Type As are physiologically hyperreactive to environmental stimuli and 14 studies which failed to support this hypothesis. During the course of the present study, Case, Heller, Case, and Moss (1985) reported in the New England Journal of Medicine that "we were unable to find a relation between Type A behavior, as measured by the JAS, and the course of coronary artery disease..."(p. 739). It is the contention of this author that physiologic reactivity may mediate the relationship between Type A and CHD in such studies and must be controlled for in order to determine if Type A/B has any effect at all.

If Type As and Type Bs are equally likely to be physiologically reactive, perhaps Type Bs who are reactive choose to avoid stress provoking challenges of the kind that Type As relish. Type Bs may appraise physiologic reactivity as distressing whereas Type As may evaluate it as preparedness convincing themselves that such arousal facilitates good performance. The attributions of these subgroups of individuals are certainly an area ripe for research and is currently being addressed by this author.

Since reactive Type As may elect to push ahead in spite of physiologic upheavals, the frequency of such experiences should place them at greater risk for cardiovascular pathophysiology than Type B reactives, whose psychophysiological reactivity cues them to avoid stressful situations. This may account for the greater frequency of Type As who develop CHD compared to Type Bs. While less than half as many Type Bs develop CHD as Type As, some Type Bs <u>do</u> develop CHD. It would be consistent with the premise of this study that those disease prone Type Bs would be more physiologically reactive.

Further validation research of the ANSRI is still in order, as are prospective studies of the health problems of reactives vs. nonreactives, particularly those who are also Type A. It is clear that physiologic reactivity is a variable which warrants further study and may lead to more suitable treatments for acutely at-risk individuals. Research into the attributions, cognitions, and affect of reactive Type As might also enhance the general understanding of the psycho-physio-logic intercourse that may predispose individuals to premature death and disease.

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Appendix A

The Jenkins Activity Survey

Form T

Medical research is trying to track down the causes of several diseases which are attacking increasing numbers of people. This survey is part of such a research effort.

Please answer the questions on the following pages by marking the answers that are true for you. Each person is different, so there are no "right" or "wrong" answers. Of course, all you tell us is strictly confidential--to be seen only by the research team. Do not ask anyone else about how to reply to the items. It is your personal opinion that we want.

Your assistance will be greatly appreciated.

For each of the following items, please circle the number of the ONE best answer:

1. Do you ever have trouble finding time to get your hair cut or styled?

   1. Never 2. Occasionally 3. Almost always

2. Does college "stir you into action"?

   1. Less often than most college students
   2. About average
   3. More often than most college students

3. Is your everyday life filled most by

   1. Problems needing solution
   2. Challenges needing to be met
   3. A rather predictable routine of events
   4. Not enough things to keep me interested or busy

4. Some people live a calm, predictable life. Others find themselves often facing unexpected changes, frequent interruptions, inconveniences or "things going wrong". How often are you faced with these minor (or major) annoyances of frustrations?

   1. Several times a day
   2. About once a day
   3. A few times a week
   4. Once a week
   5. Once a month or less

For each of the following items, please circle the number of the ONE best answer:

5. When you are under pressure or stress, do you usually:

   1. Do something about it immediately
   2. Plan carefully before taking any action

6. Ordinarily, how rapidly do you eat?

   1. I'm usually the first one finished
   2. I eat a little faster than average
   3. I eat at about the same speed as most people
   4. I eat more slowly than more people

7. Has your spouse or some friend ever told you that you eat too fast?

   1. Yes, often
   2. Yes, once or twice
   3. No, no one has told me this

8. How often do you find yourself doing more than one thing at a time, such as working while eating, reading while dressing, figuring out problems while driving?

   1. I do two things at once whenever practical
   2. I do this only when I'm short of time
   3. I rarely or never do more than one thing at a time

9. When you listen to someone talking, and this person takes too long to come to the point, do you feel like hurrying him along?

   1. Frequently 2. Occasionally 3. Almost never

10. How often do you actually "put words in his mouth" in order to speed things up?

   1. Frequently 2. Occasionally 3. Almost never

11. If you tell your spouse or friend that you will meet them somewhere at a definite time, how often do you arrive late?

   1. Once in a while 2. Rarely 3. I am never late

12. Do you find yourself hurrying to get places even when there is plenty of time?

   1. Often 2. Occasionally 3. Rarely or never

For each of the following items, please circle the number of the ONE best answer:

13. Suppose you are to meet someone at a public place (street corner, building lobby, restaurant) and the other person is already 10 minutes late. Will you:

    1. Sit and wait
    2. Walk about while waiting
    3. Usually carry some reading matter or writing paper so you can get something done while waiting

14. When you have to "wait in line", such as at a restaurant, a store, or the post office, do you:

    1. Accept it calmly
    2. Feel impatient but do not show it
    3. Feel so impatient that someone watching could tell you were restless
    4. Refuse to wait in line, and find ways to avoid such delays

15. When you play games with young children about 10 years old, how often do you purposely let them win?

    1. Most of the time
    2. Half the time
    3. Only occasionally
    4. Never

16. Do most people consider you to be:

    1. Definitely hard-driving and competitive
    2. Probably hard-driving and competitive
    3. Probably more relaxed and easy going
    4. Definitely more relaxed and easy going

17. Nowadays, do you consider yourself to be:

    1. Definitely hard-driving and competitive
    2. Probably hard-driving and competitive
    3. Probably more relaxed and easy going
    4. Definitely more relaxed and easy going

18. How would your spouse (or close friend) rate you?

    1. Definitely hard-driving and competitive
    2. Probably hard-driving and competitive
    3. Probably relaxed and easy going
    4. Definitely relaxed and easy going

For each of the following items, please circle the number of the ONE best answer:

19. How would your spouse (or best friend) rate your general level of activity?

    1. Too slow; should be more active
    2. About average; is busy much of the time
    3. Too active; needs to slow down

20. Would people who know you well agree that you take your work too seriously?

    1. Definitely yes
    2. Probably yes
    3. Probably no
    4. Definitely no

21. Would people who know you well agree that you have less energy than most people?

    1. Definitely yes
    2. Probably yes
    3. Probably no
    4. Definitely no

22. Would people who know you well agree that you tend to get irritated easily?

    1. Definitely yes
    2. Probably yes
    3. Probably no
    4. Definitely no

23. Would people who know you well agree that you tend to do most things in a hurry?

    1. Definitely yes
    2. Probably yes
    3. Probably no
    4. Definitely no

24. Would people who know you well agree that you enjoy "a contest" (competition) and try hard to win?

    1. Definitely yes
    2. Probably yes
    3. Probably no
    4. Definitely no

25. Would people who know you well agree that you get a lot of fun out of your life?

    1. Definitely yes
    2. Probably yes
    3. Probably no
    4. Definitely no

26. How was your "temper" when you were younger?

    1. Fiery and hard to control
    2. Strong, but controllable
    3. No problem
    4. I almost never got angry

For each of the following items, please circle the number of the ONE best answer:

27. How is your "temper" nowadays?

1. Fiery and hard to control
2. Strong, but controllable
3. No problem
4. I almost never got angry

28. When you are in the midst of studying and someone interrupts you, how do you usually feel inside?

1. I feel O.K. because I work better after an occasional break
2. I feel only mildly annoyed
3. I really feel irritated because most such interruptions are unnecessary

29. How often are there deadlines in your courses? (If deadlines occur irregularly, please circle the closest answer below.)

1. Daily or more often
2. Weekly
3. Monthly
4. Never

30. Do these deadlines usually:

1. Carry minor pressure because of their routine nature
2. Carry considerable pressure, since delay would upset things a great deal

(Remember, the answers on these Questionnaires are confidential information and will not be revealed to officials of your university.)

31. Do you ever set deadlines or quotas for yourself in courses or other things?

1. No
2. Yes, but only occasionally
3. Yes, once per week or more often

32. When you have to work against a deadline, is the quality of your work:

1. Better
2. Worse
3. The same (pressure makes no difference)

33. In school do you ever keep two projects moving forward at the same time by shifting back and forth rapidly from one to the other?

For each of the following items, please circle the number of the ONE best answer:

34. Do you maintain a regular study schedule during vacations such as Thanksgiving, Christmas, and Easter?

1. Yes 2. No 3. Sometimes

35. How often do you bring your work home with you at night or study materials related to your courses?

1. Rarely or never
2. Once a week or less often
3. More than once a week

36. How often do you go to the university when it is officially closed (such as nights or weekends)? If this is not possible, circle here: 0

1. Rarely or never
2. Occasionally (less than once a week)
3. Once or more a week

37. When you find yourself getting tired while studying, do you usually:

1. Slow down for a while until your strength comes back
2. Keep pushing yourself at the same pace in spite of the tiredness

38. When you are in a group, do the other people tend to look to you to provide leadership?

1. Rarely
2. About as often as they look to others
3. More often than they look to others

39. Do you make yourself written lists of "things to do" to help you remember what needs to be done:

1. Never 2. Occasionally 3. Frequently

ON EACH OF THE FOLLOWING QUESTIONS, PLEASE COMPARE YOURSELF WITH THE AVERAGE STUDENT AT YOUR UNIVERSITY. PLEASE CIRCLE THE MOST ACCURATE DESCRIPTION.

40. In amount of effort put forth, I give:

1. Much more effort 3. A little less effort
2. A little more effort 4. Much less effort

ON EACH OF THE FOLLOWING QUESTIONS, PLEASE COMPARE YOURSELF WITH THE AVERAGE STUDENT AT YOUR UNIVERSITY. PLEASE CIRCLE THE MOST ACCURATE DESCRIPTION.

41. In sense of responsibility, I am:

    1. Much more responsible
    2. A little more responsible
    3. A little less responsible
    4. Much less responsible

42. I find it necessary to hurry:

    1. Much more of the time
    2. A little more of the time
    3. A little less of the time
    4. Much less of the time

43. In being precise (careful about detail), I am:

    1. Much more precise
    2. A little more precise
    3. A little less precise
    4. Much less precise

44. I approach life in general:

    1. Much more seriously
    2. A little more seriously
    3. A little less seriously
    4. Much less seriously

Would you please give the following information? (All answers are confidential; information is used for research purpose only.)

Your name ____________________ Soc. Sec. No. ____________

Today's date ________________ Birthdate _______________

Weight _____________________ Height __________________

Highest weight ______________ At age __________________

College year ________________

Permanent address ____

____
City State Zip

Thank you for your cooperation.

Appendix B

Autonomic Nervous System Response Inventory (ANSRI)

Instructions

On the next page, you will find a list of some of the physiological changes that people report often occur during various emotional experiences. The purpose of this inventory is to determine what kinds of physiological responses occur when YOU are in certain emotional states.

The inventory makes no pretense to know what makes a given person afraid or angry or sad or happy, and as such, it asks you to provide your own definition of each emotion. Here is how you can do that for the emotion, ANGER:

1. Think of a time, or the time, when you were most CLEARLY and INTENSELY angry.
2. Try to recreate that situation as vividly in your imagination as you can. Remember how you felt.
3. As a check, determine if those feelings correspond to those that were present at other times when you were markedly angry. If you have similar feelings while imagining the situation, consider those as well.
4. Turn to the list of physiological responses on the next page and line up the answer sheet so that the "Angry" column is to the immediate right of the inventory items and the numbers of the items and the answers match.
5. Go down the list of inventory items, one by one, and rate the degree to which you experienced each physiological response (either in the original situation or during imagery).

   a. If the item as stated does not apply to your anger experience, or if you simply don't remember whether it occurred or not, fill in the circle under the number "1".
   b. If you remember feeling that way, but only a little, fill in the circle under the number "2".
   c. If you remember feeling that way, and it was to a moderate degree, fill in the circle under the number "3".
   d. If you remember feeling that way, and the feeling was strong, fill in the circle under the number "4".
   e. If you remember feeling that way, and the feeling was very strong, fill in the circle under the number "5".

When you have finished the inventory under "Anger", you will have developed, in part, your own definition of the emotion "anger".

To complete the inventory, repeat steps 1-5 above, using situations in which you were CLEARLY and INTENSELY competitive. Be sure to complete all items for anger before answering the same items for the competitive column.

You may begin now.

Autonomic Nervous System Response Inventory (ANSRI)

Items

1. Heart beat fast.................................... 1
2. Heart beat slowly.................................. 2
3. Heart beat became erratic.......................... 3
4. Heart "pounded", beat heavily...................... 4
5. Rhythmic "pounding headache"....................... 5
6. Skin became reddened, flushed, either uniformly or in patches... 6
7. Skin became whitened, pale, either uniformly or in patches.. 7
8. Became dizzy....................................... 8
9. Fingers and/or toes tingled, a feeling of "pins and needles"... 9
10. Skin (particularly face) felt warm................ 10
11. Skin (particularly hands) felt cool............... 11
12. Rashes developed on skin.......................... 12
13. Palms of hands and/or fingers and/or feel perspired. 13
14. Armpits and/or skin behind knees perspired......... 14
15. Forehead and/or upper lip perspired............... 15
16. "Goose bumps" ("goose flesh") appeared on arms and/or legs.. 16
17. Back of neck and/or spine "tingled" or got "chills". 17
18. Ground teeth...................................... 18
19. Clenched jaws..................................... 19
20. Neck muscles became tense......................... 20
21. Forehead became tense, frowned.................... 21
22. Steady, dull headache in forehead or back of head... 22
23. Arm muscles became tense.......................... 23
24. Leg muscles became tense.......................... 24
25. Clenched fists.................................... 25
26. Muscles trembled.................................. 26
27. Back ached.. 27
28. Felt weakness in muscles.......................... 28
29. Breathing became rapid............................ 29
30. Breathing became slow............................. 30
31. Breathing became deep............................. 31
32. Breathing became shallow.......................... 32
33. Breathing became erratic.......................... 33
34. Mouth became dry or saliva became thick........... 34
35. Salivated excessively............................. 35
36. Throat "caught", needed to be cleared............. 36
37. Eyes teared or began to tear...................... 37
38. Stomach was agitated (e.g., butterflies).......... 38
39. Stomach cramped................................... 39
40. Stomach was acid: stomach, throat and "food pipe" (esophagus) burned................................ 40
41. Became nauseous................................... 41
42. Stomach released gasses........................... 42
43. Lower (large) intestine released gasses........... 43
44. Noteworthy urge to urinate........................ 44
45. Inability to urinate.............................. 45
46. Noteworthy urge to move bowels.................... 46
47. Inability to move bowels.......................... 47
48. Felt notably energized, ready to act.............. 48
49. Felt notably reluctant to act..................... 49
50. Vision blurred, "saw double"...................... 50
51. Saw spots before eyes............................. 51

Autonomic Nervous System Response Inventory (ANSRI)

Answer Sheet

1=not at all; 2=little; 3=moderate; 4=strong; 5=very strong

------------Angry-----------												--------Competitive---------										
No.	1	2	3	4	5	No.	1	2	3	4	5	No.	1	2	3	4	5	No.	1	2	3	4	5
1.	0	0	0	0	0	26.	0	0	0	0	0	1.	0	0	0	0	0	26.	0	0	0	0	0
2.	0	0	0	0	0	27.	0	0	0	0	0	2.	0	0	0	0	0	27.	0	0	0	0	0
3.	0	0	0	0	0	28.	0	0	0	0	0	3.	0	0	0	0	0	28.	0	0	0	0	0
4.	0	0	0	0	0	29.	0	0	0	0	0	4.	0	0	0	0	0	29.	0	0	0	0	0
5.	0	0	0	0	0	30.	0	0	0	0	0	5.	0	0	0	0	0	30.	0	0	0	0	0
6.	0	0	0	0	0	31.	0	0	0	0	0	6.	0	0	0	0	0	31.	0	0	0	0	0
7.	0	0	0	0	0	32.	0	0	0	0	0	7.	0	0	0	0	0	32.	0	0	0	0	0
8.	0	0	0	0	0	33.	0	0	0	0	0	8.	0	0	0	0	0	33.	0	0	0	0	0
9.	0	0	0	0	0	34.	0	0	0	0	0	9.	0	0	0	0	0	34.	0	0	0	0	0
10.	0	0	0	0	0	35.	0	0	0	0	0	10.	0	0	0	0	0	35.	0	0	0	0	0
11.	0	0	0	0	0	36.	0	0	0	0	0	11.	0	0	0	0	0	36.	0	0	0	0	0
12.	0	0	0	0	0	37.	0	0	0	0	0	12.	0	0	0	0	0	37.	0	0	0	0	0
13.	0	0	0	0	0	38.	0	0	0	0	0	13.	0	0	0	0	0	38.	0	0	0	0	0
14.	0	0	0	0	0	39.	0	0	0	0	0	14.	0	0	0	0	0	39.	0	0	0	0	0
15.	0	0	0	0	0	40.	0	0	0	0	0	15.	0	0	0	0	0	40.	0	0	0	0	0
16.	0	0	0	0	0	41.	0	0	0	0	0	16.	0	0	0	0	0	41.	0	0	0	0	0
17.	0	0	0	0	0	42.	0	0	0	0	0	17.	0	0	0	0	0	42.	0	0	0	0	0
18.	0	0	0	0	0	43.	0	0	0	0	0	18.	0	0	0	0	0	43.	0	0	0	0	0
19.	0	0	0	0	0	44.	0	0	0	0	0	19.	0	0	0	0	0	44.	0	0	0	0	0
20.	0	0	0	0	0	45.	0	0	0	0	0	20.	0	0	0	0	0	45.	0	0	0	0	0
21.	0	0	0	0	0	46.	0	0	0	0	0	21.	0	0	0	0	0	46.	0	0	0	0	0
22.	0	0	0	0	0	47.	0	0	0	0	0	22.	0	0	0	0	0	47.	0	0	0	0	0
23.	0	0	0	0	0	48.	0	0	0	0	0	23.	0	0	0	0	0	48.	0	0	0	0	0
24.	0	0	0	0	0	49.	0	0	0	0	0	24.	0	0	0	0	0	49.	0	0	0	0	0
25.	0	0	0	0	0	50.	0	0	0	0	0	25.	0	0	0	0	0	50.	0	0	0	0	0

P (Physiological) Scales

P1...Cardiac *

1. Heart beat fast.
2. Heart beat slowly. (-)
3. Heart beat became erratic.
4. Heart "pounded", beat heavily.

P2...Cardiovascular *

5. Rhythmic "pounding headache" in eyes or temple.
6. Skin became reddened, flushed, either uniformly or in patches.
7. Skin became whitened, pale, either uniformly or in patches.
8. Became dizzy.
9. Fingers and/or toes tingled, a feeling of "pins and needles".
10. Skin (particularly face) felt warm.
11. Skin (particularly hands) felt cool.
50. Vision blurred, "saw double".
51. Saw spots before eyes.

P6...Skin *

6. Skin became reddened, flushed, either uniformly or in patches.
7. Skin became whitened, pale, either uniformly or in patches.
10. Skin (particularly face) felt warm.
11. Skin (particularly hands) felt cool.
12. Rashes developed in skin.

P4...Sudomotor

13. Palms of hands and/or fingers and/or feet perspired.
14. Armpits and/or skin behind knees perspired.
15. Forehead and/or upper lip perspired.

P5...Piloerection

16. "Goose bumps" ("goose flesh") appeared on arms and/or legs.
17. Back of neck and/or spine "tingled" or got "chills".

P6...Muscle Tension

18. Ground teeth.
19. Clenched jaws.
20. Neck muscles became tense.
21. Forehead became tense, frowned.
22. Steady, dull headache in forehead or back of head.
23. Arm muscles became tense.
24. Leg muscles became tense.
25. Clenched fists.
26. Muscles trembled.
27. Back ached.
28. Felt weakness in muscles

P7...Respiration *

29. Breathing became rapid.
30. Breathing became slow. (-)
31. Breathing became deep.
32. Breathing became shallow.
33. Breathing became erratic.
34. Mouth became dry or saliva became thick.

P8...Gastrointestinal

34. Mouth became dry or saliva became thick.
35. Salivated excessively.
36. Throat "caught", needed to be cleared.
38. Stomach was agitated (e.g., butterflies).
39. Stomach cramped.
40. Stomach was acid: stomach, throat and "food pipe" (esophagus) burned.
41. Became nauseous.
42. Stomach released gasses.
43. Lower (large) intestine released gasses.

P9...Excretory *

44. Noteworthy urge to urinate.
45. Inability to urinate.
46. Noteworthy urge to move bowels.
47. Inability to move bowels.

P10..Energy Activation *

48. Felt notably energized, ready to act.
49. Felt notably reluctant to act. (-)

P11..Eyes

37. Eyes teared or began to tear.
50. Vision blurred, "saw double".
51. Saw spots before eyes.

P12..Thermoregulation *

6. Skin became reddened, flushed, either uniformly or in patches.
7. Skin became whitened, pale, either uniformly or in patches.
10. Skin (particularly face) felt warm.
11. Skin (particularly hands) felt cool.
12. Rashes developed on skin.
13. Palms of hands and/or fingers and/or feet perspired.
14. Armpits and/or skin behind knees perspired.
15. Forehead and/or upper lip perspired.
16. "Goose bumps" ("goose flesh") appeared on arms and/or legs.
17. Back of neck and/or spine "tingled" or got "chills".

Appendix C

Pacific Psychophysiologic Reactivity Scale

This questionnaire is designed to examine people's reactions to a variety of situations. The information obtained from this material will help further the understanding of the relationship between lifestyle and health. Please accurately mark your answers as they apply to you. Please write your name on this form. All responses will remain anonymous.

For each of the following items indicate by circling a number from one to nine on the accompanying scale the degree to which the statement applies to you. For example:

When speaking before a group, my palms are usually____.

1	2	3	4	5	6	7	8	9
Very dry								Very sweaty

This person noticed having slightly sweaty palms more often than dry palms when speaking before a group.

Please read each of the alternatives carefully, and answer as honestly as possible. There are not right or wrong answers, and you may use as much time as necessary to complete the form.

1. If I am faced with an important decision to make _____.

1	2	3	4	5	6	7	8	9
I remain calm and pensive								I feel pressured and my muscles tense

2. In the middle of a telephone conversation with my boss, I __________ get a dry throat.

1	2	3	4	5	6	7	8	9
Never								Frequently

3. During a difficult day at work, I urinate ________.

1	2	3	4	5	6	7	8	9
Less often than usual								More often than usual

4. When speaking before a group, my palms are usually ___.

1	2	3	4	5	6	7	8	9
Very dry								Very sweaty

5. On especially difficult days, I find that I ________.

1	2	3	4	5	6	7	8	9
Perspire no more than any other day								Sweat profusely

6. Just prior to making a speech, my mouth ________.

1	2	3	4	5	6	7	8	9
Feels moist as usual								Gets dry and pastey

7. Before taking an exam, my hands are ________.

1	2	3	4	5	6	7	8	9
Completely dry								So sweaty that the pen slips when I begin the test

8. When I'm driving to work/school, and I know that I'm going to be late, I ________.

1	2	3	4	5	6	7	8	9
Remain calm								Feel agitated with rapid heart rate

9. When challenged by a colleague, my respiration ______.

1 2 3 4 5 6 7 8 9

Remains unchanged — Speeds dramatically

10. When I'm sitting in front of the T.V. and the screen suddenly flashes "Bulletin" or "Special Report", my body tends to ______.

1 2 3 4 5 6 7 8 9

Become warm — Chill

11. When watching an athletic event on T.V. in which I have a favorite team, my heart rate ______.

1 2 3 4 5 6 7 8 9

Is no different than usual — Increases dramatically

12. When a business meeting requires that I talk a lot, I ______ have difficulty catching my breath.

1 2 3 4 5 6 7 8 9

Seldom — Often

13. When I am in a group and the subject of conversation quickly turns to me, I ______.

1 2 3 4 5 6 7 8 9

Am usually unaffected — Become flushed and shakey

14. I ______ experience constipation during a busy work week.

1 2 3 4 5 6 7 8 9

Rarely — Often

15. When a teacher singles me out in class, I feel _______.

1	2	3	4	5	6	7	8	9
No different								Panicky, like my heart is beating a mile a minute

16. As I sift through the mail in search of the postcard with my semester grades, I am __________.

1	2	3	4	5	6	7	8	9
Calm and relaxed								Extremely nervous with quickened heart rate

17. When speaking before a group, for example during a class or business lecture, my mouth __________.

1	2	3	4	5	6	7	8	9
Seems normal								Gets very dry

18. When confronted by my boss, the palms of my hands usually __________.

1	2	3	4	5	6	7	8	9
Remain dry								Begin to sweat

19. When I am facing a deadline, my stomach feels ________.

1	2	3	4	5	6	7	8	9
Like it always does								Upset with indigestion

20. In an interview, I am usually __________.

1	2	3	4	5	6	7	8	9
Calm								Nervous and perspiring

21. When speaking to an attractive member of the opposite sex, my palms ________.

1	2	3	4	5	6	7	8	9
Feel dry								Feel sweaty

22. When waiting in a long line at the bank my heart rate ________.

1	2	3	4	5	6	7	8	9
Stays the same								Accelerates quickly

23. I ________ experience diarrhea during a busy work week.

1	2	3	4	5	6	7	8	9
Rarely								Often

24. When asked to defend my point of view in an important meeting, I ________.

1	2	3	4	5	6	7	8	9
Never feel flushed								Frequently feel flushed

25. At a party, when I find myself leading the conversation and all eyes are on me, I ________.

1	2	3	4	5	6	7	8	9
Seldom								Often

26. Just prior to an important examination, my hands _____.

1	2	3	4	5	6	7	8	9
Feel warm and dry								Get cold and sweaty

27. In a stressful situation, it is ________ for me to have a nervous tic or shake.

1	2	3	4	5	6	7	8	9
Uncommon								Common

28. I __________ experience tension headaches.

1	2	3	4	5	6	7	8	9
Seldom								Often

29. When I am under a lot of pressure from job, family, friends, I __________ experience impotence/frigidity.

1	2	3	4	5	6	7	8	9
Never								Frequently

30. If on my way home from work I am stopped by a passing train, my stomach muscles would probably feel ________.

1	2	3	4	5	6	7	8	9
Relaxed								Tight/ tensed

31. Just before the first date with a person I care a great deal about, I __________.

1	2	3	4	5	6	7	8	9
Feel relaxed; at ease								Am extremely anxious with rapid heart rate

32. When addressed by a superior, it is very __________ for my hands to tremble.

1	2	3	4	5	6	7	8	9
Unusual								Common

Appendix D

CONSENT FORM

Thank you for coming today. In this experiment, we are studying the performance and physiologic responses of persons while they work on various tasks. Six such tasks will be presented to you, during which time we will record your heart rate, blood pressure, and galvanic skin response. Your name was drawn from a group of undergraduates who completed a lifestyle questionnaire. All responses to the following tasks will remain strictly confidential, and names will be erased once all of the data is collected. You will receive $5.00 for your participation in this study.

I understand these statements and choose to participate in this study.

____________________________ ____________

Name Date

Appendix E

Physiologic Data

Subject # ______________ Name ____________________ Date ____________

Task	Trial #	SBP	DBP	HR	EDR x 60
Rest	1				
DR1	2				
DR2	3				
DR3	4				
BD1	5				
BD2	6				
BD3	7				
Rest	8				

Performance Data

Task	Stimulus	Score	Time
DR1	6-2-9		
	4-1-5		
	7-9-4		
	8-5-7		
	7-3-1		
	9-4-2		
	1-7-9		
	2-5-9		
	3-8-1		
	2-5-3		
DR2	1-5-2-8-6		
	6-1-8-4-3		
	7-2-4-8-5		
	8-1-4-9-3		
	3-8-4-8-6		
	1-3-5-8-9		
	6-5-4-7-3		
	8-7-2-3-4		
	9-3-6-5-1		
	6-2-7-3-4		
	5-6-2-9-7		
DR3	7-2-8-1-9-6-5		
	9-4-3-7-6-2-5		
	4-7-3-9-1-2-8		
	8-1-2-9-3-6-5		
	3-5-1-9-8-2-4		
	6-2-3-5-8-4-7		
	2-4-7-9-1-3-6		
	4-7-5-6-9-1-2		
	8-7-2-5-6-4-1		
	3-5-6-9-1-2-7		
BD1	1		
	2		
	3		
BD2	4		
	5		
	6		
BD3	7		
	8		
	9		
	10		

Appendix F

Subjective Arousal Questionnaire

Name ______________________________ Soc. Sec. No. ______________

1. I found the task to be __________.

1	2	3	4	5	6	7	8	9
Very easy								Very difficult

2. I felt __________ while performing the task.

1	2	3	4	5	6	7	8	9
Very calm, relaxed								Very anxious

3. During the task, my heart rate __________.

1	2	3	4	5	6	7	8	9
Was no different than usual								Increased dramatically

4. During the task, my hand felt __________.

1	2	3	4	5	6	7	8	9
Warm and dry								Cold and sweaty

5. During the task, my respiration rate __________.

1	2	3	4	5	6	7	8	9
Remained unchanged								Accelerated rapidly

6. Overall, I performed __________ on this task.

1	2	3	4	5	6	7	8	9
The worst that I could								The best that I could

7. I probably performed better than __________ percent of the other students on this task.

10%	20%	30%	40%	50%	60%	70%	80%	90%

8. I would prefer to have a __________ task the next time.

1	2	3	4	5	6	7	8	9
Much easier								Much more difficult

9. Please offer one reason that you did (so well to so poorly) on this task.

____

____

____

Please turn this sheet over when you are finished and we will begin the next phase.

Appendix G

Debriefing

Dear ______________________,

The "Type A" behavior pattern has received increasing attention from health professionals because of its link to the development of coronary heart disease (CHD). Unfortunately, Type A is a relatively poor predictor of future development of heart disease (only 1% of Type As actually develop CHD). For that reason, several researchers, including myself, have begun to look beyond the simple Type A-Type B classification to determine what other variables might protect or threaten subgroups of Type As and Type Bs. Our hypothesis is that physiologically nonreactive Type As may not be at any greater risk for CHD development than their Type B counterparts. On the other hand, physiologically reactive Type As and possibly even reactive Type Bs may be at greater risk for arteriosclerosis by virtue of the greater frequency of hemodynamic shifts that may ultimately lead to arterial tears and plaque formations.

Your Type A-B score on the Jenkins Activity Survey was _____________, which places you in the Type _______________ range of the distribution. Your self-reported degree of physiologic reactivity was ______________, your resting blood pressure during the experiment was _____________, which places you in the _______________ range of the distributions.

Remember that Type Bs are not considered at risk for development of CHD for any behavioral reasons; however, this does not take into account other risk factors such as obesity, family history, diabetes, or elevated serum cholesterol. If you scored Type A - reactive or if your blood pressure exceeded the norm you may wish to have your blood pressure and serum cholesterol checked regularly by a physician, although there is still no definitive evidence that these factors alone increase your health risk. Again, thank you for your participation in our study. I can be reached at the Department of Psychology, 466-4316, if you have any further questions.

Sincerely,

Tim Toben